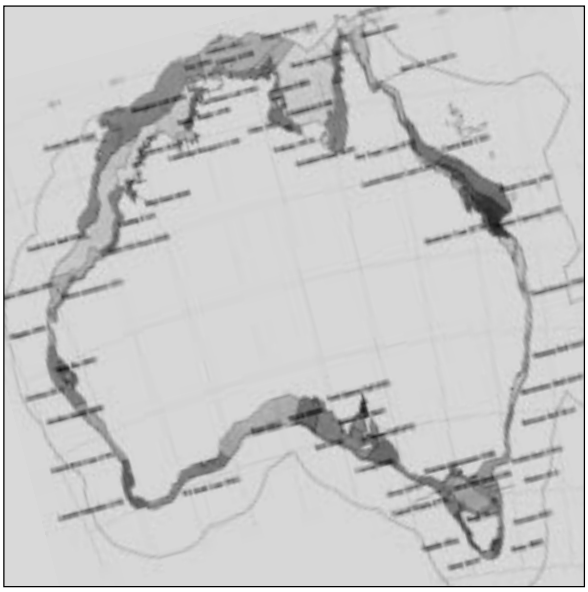
Interim Marine and Coastal Regionalisation for Australia:

An ecosystem-based classification
for marine and coastal environments



IMCRA Technical Group
June 1998 • Version 3.3

The regionalisations presented in this report were compiled from regional frameworks developed by the Commonwealth, States and Northern Territory marine management and research agencies. The compilation was coordinated by the Biodiversity Group, Environment Australia. IMCRA Version 3.3 was developed through the technical input, information and advice of the following agencies and individuals. Numerous people contributed to previous versions of IMCRA and are acknowledged in the Acknowledgments.

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Acknowledgments

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First Technical Meeting: Sydney, March 1995

The NSW National Parks and Wildlife Service provided the venue and office facilities at the Manly Quarantine Station Conference Centre, as well as financial assistance. NSW Fisheries provided financial assistance. The Australian Surveying and Land Information Group provided access to Geographic Information System data on marine data boundaries from the Australian Marine Boundaries Information System. The National Resource Information Centre compiled the available national and State and Territory coastal and marine data sets as an ArcView2 application for use at the workshop.

Second Technical Meeting: Hobart, December 1995

The Tasmanian Department of Environment and Land Management provided the venue and office facilities for the meeting. The second technical meeting formed part of a five-day technical meeting on 'Managing Australia's marine environment—information needs, data collection, data management and regionalisations'. The five-day meeting was organised in association with Annie Ilett (Department of the Environment, Sport and Territories) and Steve Blake (Environmental Resources Information Network).

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Damian McRae, in consultation with staff from the various State department, organised the above technical meetings. Damian also prepared the record of meetings for each technical meeting, which provided the basis for developing the different versions of the IMCRA report.

Sharon Pretty, in cooperation with the developers of the respective State and Territory regionalisations, compiled many of the tables in this report. Rohan Fernando, in cooperation with the developers of the respective State and Territory regionalisations, compiled the IMCRA provincial and meso-scale maps and supporting meta-data. Gavan Thomas prepared Map 4, displaying provisional provinces for Australia's external territories. Fiona Ross also assisted with preparation of maps for Version 3.0. Gordon Anderson prepared Figures 1 and 2. Final edits, following the public consultation phase, were analysed and incorporated by Brian Lassig and Edward Kleverlaan.

Preface

The sea has long been treated as a gigantic 'common' of unlimited resources, but increased awareness of the vulnerability of the coasts and oceans to degradation has generated a demand for its sustainable use.

There is growing recognition of the importance and need to protect marine biodiversity for both conservation and economic reasons. Governments, the community and all users have a shared responsibility to ensure the long term viability of the biological diversity, marine system function and resource use of the estuaries, seas and oceans.

Issues of resource conflict and overuse and the need for sustainable resource use and biodiversity conservation typically occur at local and regional scales. To address these issues there is a need for a regional planning framework which encompasses data and information on ecological patterns and processes.

The commitment to develop a consistent, national, ecologically-based planning framework began in the early 1990s with the Commonwealth Government providing support for the development of a range of biogeographic research projects in the States and Northern Territory.

The development of a consistent planning framework required cooperation between marine management and research agencies at the State, Territory and Commonwealth levels. The Australian and New Zealand Environment and Conservation Council (ANZECC) was adopted as the appropriate forum for achieving this coordination and cooperation. In 1993 ANZECC established the National Advisory Committee on Marine Protected Areas to coordinate the development of the National Representative System of Marine Protected Areas (Commonwealth of Australia 1994). The name of the group was recently changed to the Task Force on Marine Protected Areas. Agencies involved in the Task Force have responsibilities for wildlife, nature conservation, fisheries and marine research.

The Interim Marine and Coastal Regionalisation for Australia (IMCRA) has been developed as a regional framework for planning resource development and biodiversity conservation. As the name implies, it is based on the best available information and is able to be progressively revised as new data and information become available. Due to the dynamic nature of ecosystems IMCRA will need to be reviewed as changes to such systems comes to hand.

Since this report is largely technical in nature, it is intended for those who are active in the management and planning of marine and coastal resources and is judged less suitable for the general public. It is also important to note the limitations and assumptions on which IMCRA is based. Several caveats and conditions for the most appropriate uses are specified in the report.

Version 3.3 of IMCRA integrates the regionalisations developed by the State, Territory and Commonwealth agencies.

Summary

This report documents the development of IMCRA and discusses how it may be used as a regional planning framework for conservation and sustainable resource use in coastal and marine environments. Several caveats and conditions are presented to assist users identify appropriate uses.

IMCRA has been developed through the collaborative efforts of State, Northern Territory and Commonwealth marine management and research agencies. Work began in 1992 with the Commonwealth Government providing support for the development of a range of biogeographic projects in the States and Northern Territory. In 1995 work began on the development of regionalisation projects for Commonwealth waters.

Two technical working groups were established to develop the required regionalisations. The inshore waters working group comprised Northern Territory and State marine management and research agencies and the Biodiversity Group, Environment Australia. The offshore waters working group was known as the Commonwealth Technical Consortium, and comprised relevant Commonwealth research agencies. To ensure information exchange and consistency of approaches between the two working groups, representatives from the two groups participated in meetings of both working groups. Progress reports from these two working groups were presented to the Task Force on Marine Protected Areas which, in turn, provided reports to the ANZECC Standing Committee on Conservation (SCC).

IMCRA was developed in three stages:

- a meso-scale regionalisation was developed by the inshore waters working group, which generally extends from the coastline to the limit of the state territorial waters;
- various provincial to meso-scale regionalisation products were developed by the offshore waters working group, which generally extended to the limit of the Australian Exclusive Economic Zone (or EEZ); and
- a synthesis of the regionalisations developed by the inshore and offshore waters working groups into several integrated biogeographic regionalisations at different scales.

IMCRA provides the first layer in a broad planning framework in which more detailed information on ecosystems must be used to assist decision-making within a region. Additional work will allow the refinement of IMCRA. Furthermore, the use of IMCRA as a planning framework for the development of the National Representative System of Marine Protected Areas will require additional information on conservation planning attributes for each region.

1. Introduction

Australia is the world's largest island. Its marine environment includes extensive coral reefs in the tropical north, rocky shores in the temperate south, sandy beaches, estuaries and bays, seagrass beds, mangrove forests, kelp beds, the open ocean, seamounts and submarine canyons, and the habitats of the continental shelf, slope and deepsea. It has some of the most diverse, unique and spectacular marine life in the world.

The establishment of a representative system of protected areas is widely regarded, both nationally and internationally, as one of the most effective mechanisms for protecting biodiversity while permitting the sustainable use of natural resources. As an island continent, Australia has a diverse range of coastal, marine and estuarine environments. As a developed nation with a maritime area larger than the continent itself, Australia has a special responsibility for the conservation and management of its marine and coastal environments and their resources.

The definition of biogeographic regions is not only an essential step in marine conservation planning, but also in bioregional or ecosystem management (Salm & Clark 1984, ACIUCN 1986, Sherman et al. 1990, Ray & McCormick-Ray 1992, Bridgewater & Ivanovici 1993). In natural ecosystems an understanding of the patterns of biodiversity, particularly habitat biodiversity, is essential for identifying an ecologically or biogeographically representative system of protected areas. It is also essential in defining scaled ecological units for holistic, integrated ecosystem management (i.e. catchment, landscape or 'seascape' management).

Australia is committed to the protection of marine biodiversity and ecological processes, and the sustainable use of marine resources, through the goals and principles of Ecological Sustainable Development (ESD). This commitment has been ratified through Australia's international responsibilities and obligations under the Convention on Biological Diversity (UNEP 1994), and implemented at a national level by the States and Territories under the Intergovernmental Agreement on the Environment (IGAE) (Commonwealth of Australia 1992a), through the development of national strategies such as the National Strategy for Ecologically Sustainable Development (Commonwealth of Australia 1992b), and the National Strategy for the Conservation of Australia's Biological Diversity (Commonwealth of Australia 1996). The establishment of a National Representative System of Marine Protected Areas (NRSMPA) is a key responsibility and obligation under the Convention on Biological Diversity (UNEP 1994), the National Strategy for Ecologically Sustainable Development (Commonwealth of Australia 1992b) and the National Strategy for the Conservation of Australia's Biological Diversity (Commonwealth of Australia 1996).

1.1 Australia's Marine Biodiversity

Australia's marine environment extends from the coastline to the boundary of its 200 nautical mile (n mile) Exclusive Economic Zone (EEZ) and covers approximately 9 million km2 of seas (an area 16% larger than the land), refer **Figure 1**. As the world's largest island, Australia has a wide range of coastal and marine environments, which extend for approximately 32,000 kilometres, from the tropical northern regions to temperate southern latitudes. Around this extensive coastline occur a wide range of habitats and biological communities including rocky shores, sandy beaches, algal reefs and kelp forests, which dominate the temperate south, and coral reefs, estuaries, bays, seagrasses beds, mangrove forests and coastal saltmarshes, which dominate the tropical north. As well as latitudinal variation, there is also the less understood mid-water, outer-shelf and deepwater habitats. Australia's marine environments also include external territories in the Indian Ocean, South Pacific Ocean, Southern Ocean and Antarctica.

The extent and diversity of Australia's marine and coastal environments has resulted in some of the most diverse, unique and spectacular marine life in the world—supporting some of the highest numbers of marine species in the world.

For instance, Australia has the world's largest areas and highest species diversity of tropical and temperate seagrasses, the highest diversity of marine macroalgae, the largest area of coral reefs, the highest mangrove species diversity, and highest global levels of biodiversity for a range of marine invertebrates (e.g. bryozoans, ascidians and nudibranchs) (Zann 1995). Approximately

4000 species of fish, 43 species of whales and dolphins, and 6 of the 7 world species of marine turtles are recorded from Australian waters.

All major groups of marine organisms are represented in Australian waters, and many species are endemic or unique to Australia's waters. In temperate southern Australian waters, which have been geographically and climatically isolated for around 65 million years, most known species (i.e. 90–95%) are endemic or restricted to the area (Poore 1995). In the waters of tropical northern Australia, which are connected by currents to the Indian and Pacific Ocean tropics, levels of endemicity are unknown due to lack of data, however, 85–90% of recorded species are shared with the Asia-Pacific region.

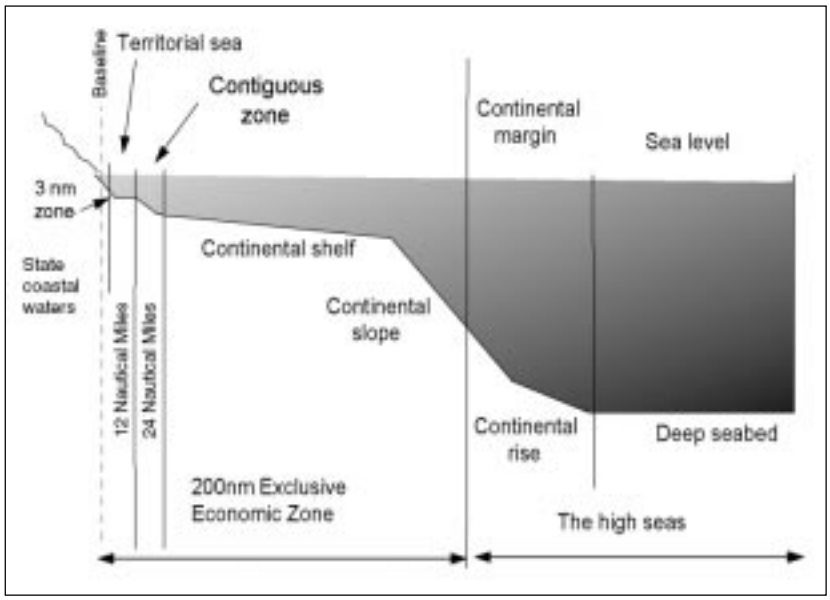
In protecting and conserving marine biodiversity it is important to recognise the hierarchical nature of ecosystems, biodiversity and ecological processes. Biodiversity can be understood, conserved and managed at a range of spatial and temporal scales. Biodiversity occurs at the macro-scales (i.e. at scales of large marine ecosystems, such as major oceanic and pelagic ecosystems) and is defined by macro-scale processes such as oceanography (i.e. currents and upwellings), trophodynamics, coastal physiography and basin topography. Biodiversity also occurs at the micro- or pica-scales of ecosystems (e.g. open coasts and gulfs), habitats (e.g. reefs, estuaries and bays) and biological communities (e.g. mangroves, seagrasses, kelp forests and coral reefs). At these scales, patterns in biodiversity may be dominated by small-scale physical processes such as the type of substratum, cyclones, storm events, tidal range and changes in wave exposure, or by biological processes such as competition and predation.

1.2 The role of bioregionalisation

1.2.1 A national representative system of marine protected areas

While protected areas in Australia have been in place for some terrestrial ecosystems for over a century, the formal conservation of Australia's marine environments and their resources is a relatively recent phenomenon. The Commonwealth and the States are now committed to an expansion of Australia's existing marine reserve system, through the establishment of a National Representative System of Marine Protected Areas (NRSMPA), which would manage and protect marine areas while allowing a range of appropriate uses and promoting public education.

Figure 1: Schematic profile of the various zones including the 200 n mile Exclusive Economic Zone and the high seas (nm = nautical mile).



The primary goal for a national representative system of MPAs is:

> *'to provide for the protection, restoration, wise use, understanding and enjoyment of marine heritage in perpetuity through the creation of a national representative system of marine protected areas and through management in accordance with the principles of the World Conservation Strategy and the national strategy for Ecologically Sustainable Development of human activities that use or affect the marine environment' (Commonwealth of Australia 1994).*

Establishing a NRSMPA also fulfils Australia's international obligations as a signatory to the Convention on Biological Diversity (UNEP 1994), which, at a global level through the World Conservation Union (IUCN) Commission on National Parks and Protected Areas (CNPPA), has been carrying out a program to promote the establishment of a global representative system of MPAs.

At a national level, a NRSMPA has been endorsed by the States and Territories under the Intergovernmental Agreement on the Environment (IGAE) (Commonwealth of Australia 1992a), and is being implemented through national strategies such as the National Strategy for Ecologically Sustainable Development (Commonwealth of Australia 1992b) (Objective 10.2), and the National Strategy for the Conservation of Australia's Biological Diversity (Commonwealth of Australia 1996) (Objective 1.4).

The recently-announced Natural Heritage Trust represents a new era for conservation and natural resources management in Australia. For the first time in the country's history, biodiversity conservation and sustainable development will be addressed in a positive and coordinated way. The Coasts and Clean Seas Program of the Natural Heritage Trust is based on partnerships between the community, governments and industry. The focus of the Coasts and Clean Seas Program will be on protecting the marine environment from the negative impacts of human activities. The Marine Protected Areas Program is one component of the Coasts and Clean Seas Program. Under the latter program, the IMCRA bioregional planning framework has been recognised as a tool to help guide the identification of areas for inclusion in the NRSMPA and ensure that it is representative of the full range of Australia's marine environments.

Through the national Marine Protected Areas Program and the ANZECC Taskforce on Marine Protected Areas, the Commonwealth Government is working cooperatively with State and Territory governments to expand the existing system of Marine Parks and Reserves, to conserve the range of Australia's coastal and marine biodiversity, and to promote the sustainable use of marine resources. The Marine Protected Areas Program is administered by Environment Australia, with management and technical advice provided by the Portfolio Marine Group, the Biodiversity Group and the Great Barrier Reef Marine Park Authority.

Elements of a NRSMPA already exist in the form of large, multiple-use Marine Parks such as the Great Barrier Reef Marine Park (Qld) and Ningaloo and Shark Bay Marine Parks (WA) and the Great Australian Bight Marine Park. In multiple-use Marine Parks, some areas are managed purely for conservation purposes, while a range of uses are allowed elsewhere, but with the over-riding objectives of conservation and sustainable use.

There is now a clear need to identify and establish MPAs to cover the full range of Australia's marine and coastal environments and patterns of biodiversity. In this way representative (or typical) examples of the full range of Australia's marine and coastal biodiversity from deep sea to estuarine environments, and from tropical waters to cold southern waters, can be protected and managed. Guidelines for the establishment of a national system of marine protected areas are in preparation.

1.2.2 Marine ecosystem management

Australia's predominantly coastal population creates significant pressures on its nearshore marine and coastal ecosystems. These pressures, such as declining water quality, loss of marine and coastal habitat, and unsustainable use of marine and coastal resources, have been exacerbated both by a lack of long-term research and monitoring, and importantly, the lack of strategic, integrated planning in Australia's marine and coastal environments (RAC 1993, Zann 1995). In this respect, ecosystem management is fundamental to the integrated, ecologically sustainable use of Australia's marine and coastal environments (Commonwealth of Australia 1992b).

In recent years, there has been an increasing focus on defining goals and principles for ecosystem management of natural systems (Kessler et al. 1992, Grumbine 1994). In general, the following principles have been identified as essential for ecosystem management:

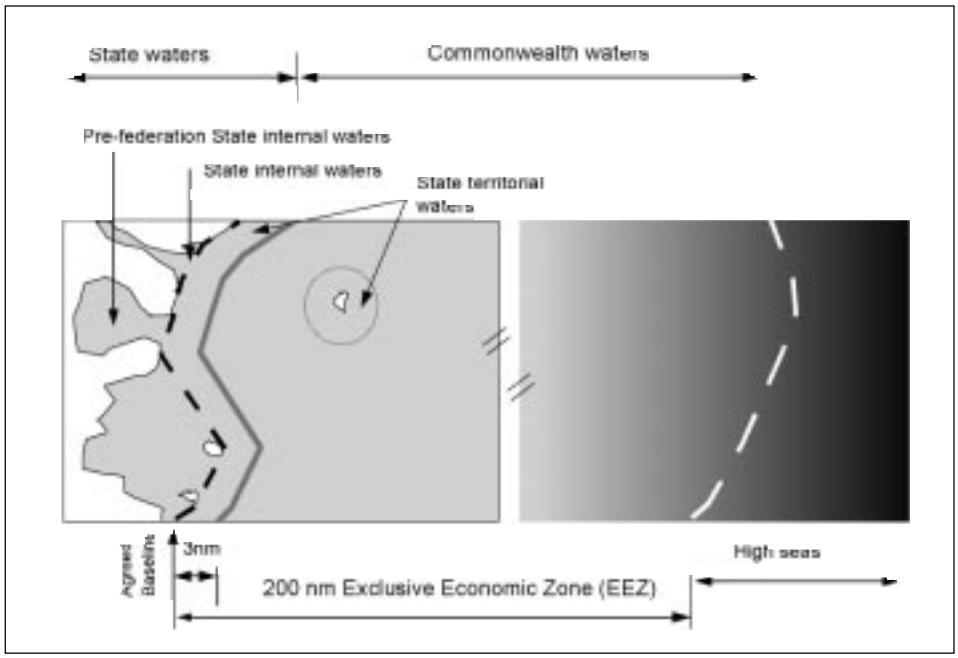
- the need for the maintenance and protection of biodiversity of ecosystems, habitats, and viable populations (primarily through representative networks of protected areas);
- corresponding maintenance and protection of evolutionary and ecological processes;
- the need for long-term research, monitoring and management; and
- the need to accommodate human use and occupancy in the management of natural systems.

The definition of ecological boundaries and an understanding of the hierarchical nature or structure of ecosystems, emerge as key elements in defining the relevant ecological units for bioregional or ecosystem management. Ecological, rather than artificial administrative/ political, boundaries for management are essential in the marine environment because of the fluid or 'connected' nature of the marine environment (i.e. the wide dispersal of organisms and pollutants by currents) and also, because human activities and the integrated management of marine resources can be hindered by a plethora of State and Commonwealth jurisdictions and agencies with artificial, administrative/political boundaries (**refer Figure 2**). Jurisdictional arrangements are made under the Offshore Constitutional Settlement (OCS) with State/Territory Governments generally having primary jurisdiction over marine areas to 3 n miles from the baseline. Special arrangements are made for fisheries management to the limit of the EEZ.

In marine ecosystems, ecosystem management specifically needs to address this higher degree of connectivity, including the integration of inshore shelf waters and offshore waters, and also the land–sea interface (i.e. catchment uses). While the concept of Large Marine Ecosystems has recently been proposed for the management of large-scale pelagic ecosystems (Sherman et al. 1990), there is a need to define the boundaries of smaller ecosystems for management of their habitats, biodiversity and resources.

Importantly, the scale and extent to which different human activities affect either biodiversity and/or ecological processes and the extent to which these human activities or impacts can be managed, determines both the scale and nature of management and monitoring required, and hence defines the framework for ecosystem management. As such, biogeographical regions or bioregions

Figure 2: Schematic map of Australia's coastal and marine realm including State and Commonwealth waters (nm = nautical mile).



provide the boundaries and framework for biodiversity or conservation management and the integrated, multiple-use management of other specific human activities or uses, such as fisheries, mining and tourism.

1.3 IMCRA

For the marine ecosystems of Australia, a biogeographic or regional ecosystem classification was first developed by relevant Commonwealth, State and Territory management agencies in 1985 (CONCOM 1985, ACIUCN 1986). The CONCOM classification was specifically developed to assist with the establishment of a National Representative System of Marine Protected Areas. However, the classification was generalised, broadscale and lacked sufficient detail to assist bioregional conservation planning.

The development of an ecosystem-scale regionalisation of Australia's marine and coastal environments was identified as a major priority in developing a NRSMPA. In March 1994, the ANZECC Taskforce on Marine Protected Areas coordinated a national workshop in Sydney, to identify existing classifications and to develop a single, meso-scale regionalisation for Australia. The workshop summarised recent regional classifications which had been developed by State/Territory agencies for coastal and nearshore marine environments around Australia (Muldoon 1995).

In several States, this has involved utilising analytical multivariate procedures to classify patterns in nearshore ecosystem diversity (e.g. Ortiz & Burchmore 1992, Edgar et al. 1995, Hamilton 1994, Stevens 1995, Edyvane & Baker 1995, 1996). That workshop identified the need to coordinate and integrate these existing nearshore studies, and to develop an integrated and comprehensive ecosystem classification of the nearshore and offshore marine environments of Australia, to provide:

- essential input to the process leading to the identification of candidate areas for inclusion in the national representative system of MPAs, and
- a strategic platform for sustainable use, and integrated management, of marine/coastal environments.

As a result of the 1994 ANZECC workshop, in March 1995 the Commonwealth Government funded a project to develop a single, ecosystem-level regionalisation of Australia's coastal and marine environments, to be known as the 'Interim Marine and Coastal Regionalisation of Australia' (IMCRA). The project, coordinated by Environment Australia (Biodiversity Group), identified a collaborative approach between Commonwealth and State/Territory agencies, based on the previous successful terrestrial regionalisation of Australia, known as the Interim Biogeographic Regionalisation of Australia (IBRA) (Thackway & Cresswell 1995, Thackway & McRae 1995).

The IMCRA classification was to include both a qualitative, expert or `delphic' approach and quantitative, analytical methods to biophysical regionalisation. This reflected the range of methodologies available and expertise within the jurisdictions and the highly variable quality and quantity of data available for Australia's marine and coastal environments. For instance, data for Australia's offshore waters is very limited, particularly for benthic habitats. By contrast, more information is generally available for nearshore waters and habitats adjacent to highly populated areas. In the absence of quantitative information, the qualitative approach utilised the expertise of recognised marine and coastal biological and physical researchers, and also existing descriptive, spatially-referenced, biophysical coastal and marine data sets and maps.

2 History and process of IMCRA

2.1 CONCOM and ACIUCN regionalisations

In 1985 a national regionalisation based on Ray's (1976) work was endorsed by the Council of Nature Conservation Ministers (CONCOM) as a basis for planning the development of a system of national marine protected areas in each jurisdiction. That regionalisation delineated and described at the provincial scale the major coastal and marine regions, and has become known as the CONCOM regionalisation (CONCOM 1985).

In 1986 the Australian Committee for the World Conservation Union (ACIUCN) modified the CONCOM regionalisation in their proposal for a national representative system of coastal and marine protected areas. That regionalisation became known as the ACIUCN regionalisation (Australian Committee for the IUCN 1986).

2.2 Taskforce on marine protected areas

In 1994 the Standing Committee on Conservation of the Australian and New Zealand Environment and Conservation Council (ANZECC) established the Taskforce on Marine Protected Areas (TFMPA, formerly the National Advisory Committee on Marine Protected Areas) to:

- coordinate and make recommendations for the development of a national representative system of marine protected areas for Australia and New Zealand; and
- provide a mechanism for Governments to exchange information and expertise on MPAs.

The Taskforce provides a forum for acknowledging the gaps in the existing system of MPAs, and for developing nationally consistent approaches to establishing a balance between conservation of biodiversity and sustainable resource development.

The Taskforce receives regular reports on the development of IMCRA, and in turn reports to ANZECC. The Taskforce is made up of representatives from all States and Territories and relevant Commonwealth Government agencies, many of whom are participants in the IMCRA process.

One of the major elements in the workplan for the Taskforce is the development of IMCRA. A direct outcome of the group's first meeting led to ANZECC convening a workshop in Sydney in March 1994, which identified the need to derive a meso-scale or regional level biogeographic regionalisation for both State and Northern Territory and Commonwealth waters of the EEZ (Muldoon 1995). Subsequently, a decision was made by the Commonwealth Government to fund the development of IMCRA. Successive versions of the IMCRA report have been submitted to the Taskforce for comment and improvement.

2.3 Conceptual framework and limitations of the current knowledge base

2.3.1 Hierarchical structure

At the outset the developers of IMCRA agreed on a broad hierarchical structure, including the need to consider ecological patterns and process which occur at continental, regional, local and site scales. Broadly the hierarchy of biogeographic terms agreed to are:

>1000s of km	macro-scale	continental provinces
100s–1000s of km	meso-scale	regions
10s–100s of km	micro-scale	local units
<10 km	pica-scale	sites

Dependent on requirements, various State and Northern Territory agencies were funded to develop meso-scale biogeographic regionalisations for the extent of their jurisdictions. Commonwealth agencies were funded to develop regionalisation products at the provincial and meso-scale for the whole EEZ and the coastal zone, which would enable the State and Northern Territory regionalisations to be integrated into a consistent national hierarchy of data and information for the entire EEZ.

2.3.2 Physical versus biological attributes (surrogates)

In keeping with the need for an ecologically meaningful understanding of the marine environment, various environmental data

sets (both biological and physical) have been compiled for use in developing an agreed regionalisation of the marine environment.

In the absence of detailed mapping of habitats, the general approach adopted by the developers of IMCRA has been to derive surrogates for coastal and marine environments. This process usually involved compiling the best available biological and physical data and information. Biological data sets included sponges, fishes, corals and sea grasses. Physical data sets included bathymetry, coastal geomorphology, sediments, currents, water chemistry and water temperature. This information was subsequently verified, and then classified into ecologically meaningful regions comprising similar combinations of environmental attributes. The resultant regionalisations have been interpreted and described in terms of the data and information used in the analysis.

2.3.3 Land–sea (coast)

The Australian coastal zone contains a wide variety of environments including: coastal mountain ranges and escarpments, coastal alluvial plains and monsoonal flood plains, rainforests, freshwater swamps and marshes, rivers and lakes, tropical and temperate estuaries, fringing and offshore coral reefs, seagrass and mangrove communities, pelagic and benthic environments of the continental shelf, banks and islands on the continental shelf, and remote oceanic atolls and coral reefs.

Coastal environments such as estuaries, mangroves, seagrass meadows and coral reefs provide breeding and feeding grounds for a myriad of marine species, including commercial fish species. Seagrass meadows and mangroves provide essential habitats for many species including commercial prawns, and often act as sediment traps, consolidating the sea floor and reducing the sediment load. Reefs and mangrove forests also function as barriers protecting coasts against storm damage.

IMCRA includes some basic environmental information on estuaries and mangroves and the typical coastal and marine ecosystems, e.g. fringing and offshore coral reefs and pelagic and benthic environments.

2.3.4 Shallow versus deep waters

Shallow waters generally have more detailed data and information on the species and habitats compared with deeper waters. In shallow waters, dive survey teams are often used to survey and map the boundaries of benthic habitats and to collect as comprehensively as possible, samples of flora and fauna.

In deeper waters data and information are usually collected by remote sensing techniques, with perhaps a limited number of physical samples over large areas. In deep waters biological data and information, in contrast to physical data sets, are usually not detailed, comprehensive or contiguous in space or time.

2.4 History and process used to develop IMCRA

The development of IMCRA has involved cooperation and collaboration by Australia's coastal and marine management and research agencies. A specification for developing IMCRA was circulated and agreed to by a technical meeting of the IMCRA developers in March 1995 (see **Appendix 1**).

The Biodiversity Group of Environment Australia assumed responsibility for preparing and circulating discussion papers, convening technical meetings, preparing records of meetings, compiling descriptive information and preparing maps, and editing and circulating different IMCRA versions for comment.

Two working groups, for inshore and offshore waters, were established to develop the regionalisations needed to compile the IMCRA. The inshore waters working group, comprised State and Northern Territory marine management and research agencies, and the Biodiversity Group of Environment Australia, which also coordinated the work of the group. The offshore waters working group was coordinated by the Environmental Resources Information Network of Environment Australia (ERIN). This working group was also known as the Commonwealth Technical Consortium. To ensure information exchange and consistency of approach between the two working groups, representatives from the inshore and offshore working groups participated in meetings of both working groups, when possible. As much as possible throughout the process, continuity of representation from each of the Commonwealth, State and Northern Territory marine management and

research agencies was a feature of each technical meeting.

IMCRA was developed in three stages:

- a meso-scale regionalisation developed by the inshore waters working group, which generally extend from the coastline to the limit of the State or Territory jurisdiction;
- various regionalisation products developed by the offshore waters working group, which generally extend to the limit of the Australian EEZ; and
- synthesis of the regionalisations developed by the inshore and offshore working groups into several integrated biogeographic regionalisations.

A detailed chart providing the key stages of the development of IMCRA is presented in **Table 1**.

2.4.1 Regionalisations developed by the inshore waters working group

The IMCRA project built on the progress of existing meso-scale regionalisations in the States and Northern Territory. In some jurisdictions, regionalisations were completed prior to the commencement of the IMCRA project. Where required, jurisdictions were funded by the Commonwealth Government to derive a biophysical regionalisation. Each jurisdiction/agency developed their own tabular data sets and GIS coverages. The processes used by the States and the Northern Territory to derive their respective components of the inshore waters regionalisation are presented in **Appendix 2**.

Many commonalities in the descriptions and boundaries in the existing State and Northern Territory biogeographic regionalisations can be drawn, providing the basis for synthesising descriptions and adjusting region boundaries between jurisdictions.

Through a process of national technical meetings, representatives from the relevant marine research and management agencies from each jurisdiction met to discuss progress and develop consistent approaches which would enable integration of these components into a single meso-scale regionalisation for State and Northern Territory waters. Two main approaches were used:

1. available regionalisation boundaries and descriptions were interpreted/integrated and transferred on to paper maps, and then these boundaries were digitised; and
2. where local and sub-regional-scale Geographic Information System (GIS) data sets were available, these data/regions were aggregated to derive coarser meso-scale map unit boundaries using a combination of paper base maps and GIS.

Where regions stopped at State and Northern Territory seaward borders, meso-scale boundaries were either extended to join with the adjacent meso-scale region boundaries over a border or, where appropriate, these were split to form new regions. Biophysical attributes and region descriptions provided the necessary information for deciding whether an existing region should be lumped in with another or split to form smaller regions.

Each meso-scale region was given a unique name and brief description. Where draft IMCRA regions extended across State and Northern Territory borders, agreement was reached on appropriate codes, names and descriptions. A draft national regionalisation was agreed to at 1:5 million scale.

The respective data sets (tabular and GIS) for each State and the Northern Territory were then forwarded to the Biodiversity Group where they were loaded into the national IMCRA data set and checked. The ARC/INFO spatial data base software package was used to compile, check and visually represent the relevant tabular and boundary data.

2.4.2 Regionalisations developed by the offshore waters working group

In late 1994, a consortium was formed of the following Commonwealth agencies: the Australian Geological Survey Organisation (AGSO), and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Divisions of Wildlife and Ecology, and Marine Research. This group became known as the Commonwealth Technical Consortium. In response to a proposal submitted by the Consortium (ERIN 1995), the Commonwealth Government funded a project to develop, along with other products, biophysical regionalisations for the Australian EEZ.

Prior to undertaking these regionalisations little work had been done in the deeper waters regarding compiling and integrating environmental data and information to develop a regional level spatial planning framework to assist in sustainable resource development and biodiversity conservation.

The processes used by the Commonwealth agencies to derive their respective regionalisations are presented in **Appendix 3**.

Several regionalisations were developed for the continental shelf and beyond the shelf break bringing together readily accessible data and information on biological and physical data sets. Most of the information available is suitable for analysis and presentation at the provincial scale, with some data sets providing information reliable at the meso-scale.

AGSO and CSIRO Division of Wildlife and Ecology developed an approach to regionalisation which aimed to define and describe benthic habitats based on integrating attributes for sea floor topography, sea floor sediments and the physical oceanographic water column.

CSIRO Marine Laboratories' approach to regionalisation was to define and describe patterns in the marine environment in terms of fish species composition and richness and the physical oceanographic water column.

2.4.3 Integration of regionalisation products

Table 2 presents a summary of the regionalisation products developed by the inshore and offshore waters working groups.

The table shows that the individual regionalisations may cover different geographic areas, at different scales, or be based on different combinations of biological and/or physical environmental data and information. The meso-scale regionalisations generally extend to the limits of the State and Northern Territory jurisdictions. The fish regionalisations extend to the limit of the continental shelf while the physical attribute regionalisations for sea floor topography, sea floor sediments and the physical oceanographic water column extend from the shore line to the limit of the EEZ.

The integration of the various regionalisation products began in early 1996 with the ANZECC TFMPA endorsing guidelines for integrating the regionalisations from the two working groups (see **Appendix 4**). A national technical meeting was convened for this purpose in November 1996 bringing together representatives from the two working groups.

Relevant technical specialists worked in small groups with a geographic focus. This process provided an effective mechanism for resolving issues, including the variety of biological and physical data sets used as inputs for deriving the boundaries and descriptions for the regions at the meso and provincial scales, and for reviewing and revising the boundaries and descriptions.

The decisions which shaped the integration process were:

- to establish appropriate linkages between the meso-scale and provincial scale regionalisations by extending the seaward meso-scale region boundaries to the 200 m isobath, that is, the nominal edge of the continental shelf;
- to establish appropriate spatial links between the revised meso-scale regionalisation boundaries out to the continental shelf with the demersal fish regionalisation for the continental shelf at the provincial scale, to provide a nested relationship between the two regionalisations;
- to complete the pelagic provincial scale regionalisation for the EEZ using, in the first instance, appropriate biological and/or physical information—but where this could not be achieved, using the 0–50 m physical oceanographic water column regionalisation as a surrogate for pelagic provinces for the waters beyond the shelf break; and
- to complete the demersal provincial scale regionalisation for the EEZ using the sea floor topography regionalisation as a surrogate for demersal provinces for the waters beyond the shelf break.

Figure 3 below presents a schema of the approach used to develop the IMCRA regionalisations.

Figure 3: The process used to integrate the inshore and offshore regionalisations in November 1996.

PRIMARY INPUTS		APPROACH USED		OUTPUTS
IMCRA Version 2.0 Meso-scale Regionalisation	+	Extend the seaward boundary of the meso-scale regions to the 200 metre isobath **then** spatially link *Demersal Fish Regionalisation* (provincial scale for the continental shelf) with the *Meso-scale Regionalisation* boundaries	=	**Meso-scale Regionalisation Version 3.1 (Map 1)**
Demersal Fish Regionalisation (provincial scale for the continental shelf)	+	Integrate the *Demersal Fish Regionalisation* **with the** *Sea Floor Topography* (provincial scale beyond the shelf break) to provide a surrogate for demersal provinces	=	**Demersal Provinces and Biotones Regionalisation (Map 2)**
Pelagic Fish Regionalisation (provincial scale for the continental shelf)	+	Integrate the *Pelagic Fish Regionalisation* with appropriate biological and/or physical surrogate data and information beyond the shelf break. In the absence of appropriate biological and/or physical surrogates, **then** integrate the *Pelagic Fish Regionalisation* **with** the *0–50 metre Water Column Physical Oceanographic Regionalisation* (provincial scale beyond the shelf break) to provide a surrogate for pelagic provinces	=	***Pelagic Provinces and Biotones Regionalisation* (Map 3)**

3. IMCRA

IMCRA embodies a hierarchical information structure that minimises the internal heterogeneity at each level in the hierarchy, that is, continental (provinces), regional (meso-scale regions) and local. For management purposes, further work is required to develop the information content within the meso-scale regions and local-scale patterns (e.g. benthic habitats). Further work is also required to enhance the provincial regionalisations. The provincial levels enable meso-scale and finer level information and applications to be placed in the continental context.

The development of these regionalisations should be regarded as an evolving process. As new information becomes available, it will be necessary to review and enhance the regionalisations to take account of improved data and information.

3.1 Meso-scale regions

Discussions from the IMCRA technical meetings in 1995 concentrated on the inshore regions. Regions identified in one jurisdiction were often also represented in the adjacent jurisdiction. A process was begun to describe consistent major regions that crossed State borders, completing a truly national coverage. The meso-scale regions are presented on **Map 1**. The seaward margin of the meso-scale regions is the 200 m isobath.

The number of meso-scale regions has increased from 59 to 60 since Version 2.0, reflecting the identification of two new regions and loss of one region through its incorporation into another region. The new regions are Wellesley (inshore Gulf of Carpentaria) and Oceanic Shoals (offshore North West Shelf), while Donnelly has been included in the Leeuwin-Naturaliste region. The meso-scale regions have been defined using biological and physical information and geographic distance along the coast and are described in **Table 3**. A more detailed description of the biophysical attributes for each region is presented in **Appendix 5**.

Generally the meso-scale regions form a continuous, narrow segmented band around the continent. The boundary between regions usually extends perpendicular to the coast line. This pattern is varied in shallow subtropical and tropical waters where several parallel bands extend out from the coast, in the vicinity of the North West Shelf and the Great Barrier Reef.

The largest regions (50,000–240,000 km^2) occur generally in tropical waters (ARA, OSS, CAR, NWS, KIM, KAN, MCN, PSS), with only two regions of this size occurring in temperate waters (EUC and EYR). The smallest regions (3,000–5,000 km^2) include islands (ABR), embayments (VES), coastal strips (WTC, CVA and BAT) and gulfs and sounds (NSG and KSD).

3.2 Provinces

The two provincial level regionalisations provide the coarsest or top layer of information in the IMCRA planning framework for the EEZ: the Demersal Provinces and Biotones Regionalisation **(Map 2)** and Pelagic Provinces and Biotones Regionalisation **(Map 3)**.

3.2.1. Demersal provinces and biotones regionalisation

Demersal provinces are presented on **Map 2**, which shows two distinct bands which coincide with those waters on and off the continental shelf. **Table 4** presents a description of the Demersal Provinces and Biotones.

Map 2 depicts 9 core provinces and 8 biotones on the continental shelf, and one offshore province (NorfP). Biotones are zones of transition between core provinces. These provinces and biotones are based on a classification of demersal fish species diversity and richness. The core provinces have been grouped into 4 classes (tropical, subtropical, warm and cold temperate) based on their climate characteristics in tropical to temperate waters. Core provinces and biotones tend to be larger in area in tropical waters than temperate waters, because of the greater prevalence of limited range endemic species in the temperate waters of southern Australia.

Map 2 depicts 4 topography-based classes beyond the shelf break. Information on demersal fish and biota is available to investigate provincial structuring for the slope and pelagic/mesopelagic offshore areas. However, this was not possible within the limited time frame and resourcing for the IMCRA Commonwealth project. The seafloor topographic classes provide a surrogate for the environmental domains of the deep-water demersal region.

They do not provide a surrogate for the demersal provinces, the discrimination of which will require a concerted effort to analyse the currently available biological datasets and samples.

Potential new provinces beyond the shelf break may include Northern, Central and Southern Coral Sea Provinces, off the northeast Queensland coast.

3.2.2 Pelagic provinces and biotones regionalisation

Pelagic provinces are presented on **Map 3**, which shows two distinct bands which coincide with those waters on and off the continental shelf. **Table 5** presents a description of the Pelagic Provinces and Biotones.

Map 3 shows 2 core provinces with 2 biotones on the continental shelf. These provinces and biotones are based on a classification of pelagic fish species diversity and richness.

The core province in the tropical waters is larger than the core province in the temperate waters. The biotone on the east coast is more extensive than that on the west coast.

Map 3 shows 9 classes of water mass types beyond the shelf break. The water mass types are based on a classification of water column properties, including temperature, salinity, and a range of nutrients and silicates. These classes provide a surrogate for the environmental domain of the offshore water column. The pattern of these groups shows parallel banding from north to south, intersecting the east and west coasts of Australia. The same groups occur on the east and west coasts, but with greater structuring on the west coast. Elements of subtropical convergence zone water are evident in the eastern end of the Great Australian Bight and 'wrapping' around Tasmania.

3.3 Relationships between IMCRA meso-scale regions and provincial regionalisation

The nested relationship between the IMCRA meso-scale regions and demersal provinces presented in **Map 2** is summarised in **Table 6**. The area of each region is also presented in **Table 6**.

The structure of the table shows that each demersal core province and biotone has separate meso-scale regions, except for the Victorian Embayments (VES) meso-scale region which occurs in two provinces (BassP and SEB).

The pattern of meso-scale regions within core provinces and biotones varies significantly between southern and northern waters. In southern temperate waters there are usually one to three meso-scale regions in each province or biotone, while in northern subtropical and tropical waters this ranges from 3 to 9 meso-scale regions in each province or biotone.

4. Uses of IMCRA

Regionalisations are conceived and developed for specific purposes. Ecologically based regionalisations like IMCRA provide the first layer in a broad ecological planning framework within which more detailed information on ecosystems, communities and/or species distributions must be used to assist decision-making across or within a bioregion.

IMCRA has been developed to provide a regional framework for planning sustainable resource development and biodiversity conservation. In this context the following assumptions, caveats and conditions of use are presented to assist users of IMCRA to recognise that IMCRA has been developed as a broad planning tool and to alert potential users that there may be some uses of the IMCRA regionalisation that are inappropriate. The onus rests with the user, and not the developers, to apply the regionalisation appropriately when developing products.

To enable IMCRA's use as a planning and reporting framework it is necessary to assign relevant information and attributes to each region. The information and attributes can then be summarised and manipulated to determine the 'management status' of that region. By way of example, to assist decision-makers in a policy context, it is necessary to add to the regionalisation information on current protected areas and what they contain. This will help identify gaps and set priorities for delivery and evaluation of public programs to enhance the national representative system of MPAs.

4.1 Assumptions and caveats

Regionalisations like IMCRA provide a valuable and meaningful basis for focusing attention, summarising patterns, aggregating information and allocating resources and priorities. However, it is important to understand what assumptions and limitations pertain to IMCRA before it is used for a particular application.

Considerable knowledge and effort on behalf of marine scientists and managers has been invested in the interpretation of data and information, and the re-analysis and revision of biogeographic regionalisations to develop IMCRA as an integrated continental-level planning and decision-making framework. The approach used is flexible, repeatable and hierarchical.

For many applications, regionalisations like IMCRA provide pre-classified data and information useful for the purpose. There are, however, other applications where the scale, type and number of attributes used, temporal differences between data sets, and the different analytical methods used will affect its appropriateness for use. In view of these issues, the following limitations and assumptions are provided to determine whether any application represents an appropriate use of IMCRA.

Assumption 1:
The meso-scale regionalisation embodies an integrated classification of coastal and marine ecosystems and biogeographic regions. The delineation of region boundaries and the description of the biogeographic regions seek to underpin and explain the distribution of the characteristic biotic elements of each ecosystem.

Limitation:

Ecological theory supports such an assumption, but it is recognised that there needs to be more rigorous testing of the boundaries using a range of regional and continental data sets and analytical tools.

The State and Northern Territory regionalisations have been developed using different attributes and at somewhat differing scales. The different methodologies used to derive the respective regionalisations can create inconsistencies relating to the scale of attributes and boundaries. As far as possible these differences have been taken into account in the development of the meso-scale regionalisation.

Given that the Commonwealth, State and Northern Territory marine management agencies are the custodians of the regionalisation for waters within their jurisdictions, which collectively comprise the meso-scale regionalisation, any revision for these waters is the responsibility of the respective agency in concert with their adjoining neighbour agency or agencies.

Assumption 2:
Biological patterns exist within ecologically based meso-scale regions and provinces, and may be delineated in terms of biophysical attributes that can be observed in the distribution patterns of the flora and fauna.

Limitation:

Caution needs to be applied when attempting to match the meso-scale and provincial regions with observed patterns in the distribution of fauna and flora, or to explain broad patterns of biota in terms of the IMCRA regions. The meso-scale and provincial regions act as surrogates for broadscale ecosystems and habitats and have not been extensively or rigorously tested. The IMCRA meso-scale and provincial regions are a convenient approximation of the complexity observed in the real world. Therefore, they should not be expected to yield highly precise answers in all situations, particularly in fine-scale work and applications involving individual species. It is recognised that there is a need to periodically test, refine and revise these regions and descriptions.

Assumption 3:
A hierarchy of information exists within and between the meso-scale and provincial demersal regions, embodying different levels of heterogeneity.

Limitation:

The IMCRA meso-scale and provincial regions have been derived from best available knowledge, using a variety of approaches to derive the region boundaries and their descriptions. The meso-scale and provincial regions have been nested into a hierarchy based on a reasonable rule of thumb that is based on many years of biological surveys and ecological assessments. It is recognised that there is a need to test and validate this 'hierarchy'.

Assumption 4:
The meso-scale regionalisation is a single biogeographic regionalisation which provides an ecosystem-based framework appropriate for integrated resource management, including planning the development of the NRSMPA.

Limitation:

In applying the meso-scale regions to resource management issues, the scale of the ecosystem processes involved must be considered. Application of meso-scale regions to issues controlled at the local scale may lead to the development of inaccurate or overly simplistic solutions, just as application of meso-scale regions to provincial scale issues may lead to overly intricate management prescriptions.

Caution needs to be exercised in comparing statistics and indices derived for the same level of the meso-scale regionalisation between jurisdictions, given the disparate nature of their origins. Constraints on the interpretation of such comparisons include the following:

- there is a strong dependency between classification resolution and any derived estimates of reservation adequacy; therefore, it should be recognised that the choice of resolution needs to be explicitly defined and justified; and
- any future assessment of heterogeneity within regions will be biased by the level of information available for those regions. That is, well-studied regions will usually appear more heterogeneous than less well-known regions.

Assumption 5:
The scientifically informed differences, integrity and discreteness of the IMCRA regions will be recognised by others and used as a basis for planning, reporting, monitoring and for informing management.

Limitation:

These scientifically based differences and distinctions about viewing and understanding the land/sea as a hierarchy of discrete regions may not necessarily conform with other cultural concepts of land/sea and 'place'.

Assumption 6:
IMCRA regions and their resulting hierarchical data structure will provide a mechanism for integrating 'top-down' national and regional planning and management strategies with more localised 'bottom-up' planning and management activities.

Limitation:

Many local and regional communities and interest groups, as well as some managers, currently have limited understanding of the spatial patterning and inherent sustainable carrying capacity of the various ecosystems within a region.

Assumption 7:
IMCRA regions provide a meaningful framework for assessing and reporting on a wide range of natural resource-related activities, including planning, management, monitoring and research in marine and coastal environments.

Limitation:

The links between data and information collection activities need to be strengthened in relation to IMCRA regions.

Assumption 8:
The meso-scale regionalisation shows a seaward boundary of 200 m isobath depicting the nominal limit of the continental shelf.

Limitation:

Information required to substantiate the seaward extension of the meso-scale regionalisation to the edge of the continental shelf break is based on a reasonable rule of thumb that the environmental gradients change less across shelf than along the coastline, and that the shelf break is a relevant, readily-identifiable feature. It is recognised that this needs to be further tested and validated.

Assumption 9:
The Demersal Provinces and Biotones Regionalisation and Pelagic Provinces and Biotones Regionalisation may be used for preliminary planning at the provincial scale as they provide an appropriate representation of the provincial level structuring of the marine environment.

Limitation:

The offshore oceanographic regionalisations do not provide an adequate regionalisation of the slope environment. Thus, the major spatial gaps in the current regionalisations are in the biological and physical regionalisation for the slope system, and the lack of an assembled biological regionalisation for the areas offshore of the shelf/slope.

Assumption 10:
The biotones identified are not simply 'fuzzy' boundaries around a disjunction. On the contrary many of the biotones are at least as extensive, and in some cases (such as the Great Australian Bight Biotone) are more extensive, than most of the core provincial bioregions. These biotones must be recognised as unique systems and managed with due recognition of the contribution made from core provinces.

Limitation:

The lines delimiting the biotone boundaries are approximations and may vary up to 100 kilometres dependent on a host of factors, such as seasonality of currents.

Assumption 11:
The biotones depicted in the Demersal Provinces and Biotones Regionalisation and Pelagic Provinces and Biotones Regionalisation are focussed on regional interpretations rather than being boundary-based. This way of depicting biotones is a novel concept and requires new conservation interpretations of the derived bioregions.

Limitation:

Comparisons with such conventional delphic regionalisations as the 1985 CONCOM regionalisation may be misleading if focused on the boundaries rather than the inherent characteristics of the province.

4.2 Terms and conditions of use

The following set of terms and conditions were agreed to by the developers:

1. Parties wishing to use IMCRA shall acknowledge that it has been derived by a combination of expert field ecological knowledge and interpretation of existing State, Territory and Commonwealth regionalisations.
2. Commonwealth, State and Territory fisheries and nature conservation agencies acknowledge that IMCRA has been developed for use primarily by marine management agencies and the Marine Protected Areas Program of Environment Australia to plan the development of the NRSMPA.
3. Any jurisdiction wishing to use IMCRA for purposes other than the Marine Protected Areas Program must acknowledge why it was developed and that it may not be appropriate for purposes other than planning the NRSMPA.
4. Commonwealth, State and Territory fisheries and nature conservation agencies reserve the right to develop further regionalisations, in addition to those regionalisations included in IMCRA, for their own purposes.
5. Commonwealth, State and Territory fisheries and nature conservation agencies recognise that new methodologies and data sets are likely to modify IMCRA, and that there is a need to periodically revise IMCRA to reflect these revisions.
6. IMCRA, and biogeographic regionalisations per se, should not be viewed as the only information for assessing and identifying gaps in the existing systems of MPAs, and for setting priorities to fill these gaps under the Marine Protected Areas Program.
7. Commonwealth, State and Territory agencies reserve the right to seek ratification of any IMCRA products from their respective governments, but in the first instance will seek endorsement from ANZECC.
8. Amendments to IMCRA and its associated conservation planning attributes are to be agreed on between respective jurisdictions before they are forwarded to the Biodiversity Group for loading onto the ERIN network.

4.3 Responsibilities

State, Northern Territory and Commonwealth marine management and research agencies have collaborated to develop IMCRA. The relevant agencies accept responsibility for custodianship and future enhancements as more information becomes available. Responsibility for reviewing and revising the IMCRA products lies with the various agencies which are represented on the IMCRA Technical Group.

4.3.1. Custodianship

IMCRA has been derived from the best available information using specialist ecological knowledge of structure and function of the marine environment. The developers of IMCRA recognise that IMCRA is an evolving product and that further enhancements of IMCRA maps, tables and summary descriptions must be expected as more information becomes available.

5. Towards biodiversity planning and management

5.1. IMCRA as a tool

As a spatial framework, IMCRA provides a tool for planning resource use and allocation at the meso-scale. The assumptions which underlie IMCRA should be referred to as a guide for appropriate usage. The developers of IMCRA acknowledge that as more information becomes available and is integrated into IMCRA, IMCRA will progressively become more useful for finer scale decision-making.

Depending on the issue, IMCRA can be used as the top level in a flexible decision-making framework. A variety of data and information can be compiled and analysed within and across meso-scale IMCRA regions to discover gaps in data and information, to highlight regional priorities, and to focus resource allocation and use according to ecological principles.

IMCRA should not be the only tool to identify MPAs and continued discussion with key government, industry and scientific stakeholders is recognised as vital elements to identify and develop appropriate arrangements for the protection and preservation of the marine environment.

5.1.1. Data required

Resource-use planners and biodiversity conservation managers require different data and information for various situations. Depending on the nature of the issue, most resource-use conflicts in natural systems require a range of biological and physical information collected in space and time.

The integrated spatial units of IMCRA provide a broad ecosystem-based framework which should enable a range of natural resource related issues to be considered from continental, regional, local and site scales.

5.1.2. Gaps

IMCRA can be used in two main ways as a planning framework to define gaps: it provides a useful spatial framework within which to assess ecological data and information required for biodiversity management; and a way to determine the comprehensiveness of biodiversity components within the system of marine protected areas.

5.1.2.1 Gaps in data

Conservation planning and management require access to current and reliable data and information. The meso-scale IMCRA regionalisation provides a framework within which to systematically assess which regions have adequate data and information required for biodiversity conservation.

This assessment might show that some regions have adequate physical data but inadequate biological data. Such information could be used to schedule a program of regional surveys to fill these data and information gaps.

5.1.2.2 Gaps in representativeness and comprehensiveness

Ivanovici and Bridgewater (1993) used the CONCOM regionalisation to show that most provincial level CONCOM regions in southern latitudes are not represented, or are poorly represented, in marine protected areas.

At the national level IMCRA could be used to assess the representativeness of regions (meso -scale) in protected areas. This analysis can be carried out by overlaying a map of the distribution of meso-scale regions with the distribution of marine protected areas. Such an analysis, using the meso-scale IMCRA regions, could be routinely carried out as a national report on progress toward establishing the National Representative System of Marine Protected Areas. The provincial scale may be more appropriate for reporting the representativeness of regions at a national scale, whilst the meso-scale may be more appropriate at the level of the States.

At the regional scale, where there is detailed mapping of benthic habitats (i.e. within meso-scale IMCRA regions), this analysis could be carried out to determine the comprehensiveness of the inclusion of ecosystems (micro-scale) in protected areas. In reality most areas do not have detailed mapping of benthic habitats.

5.1.3. Planning a national representative system of marine protected areas

Within the context of ecologically sustainable development, marine protected areas perform a critical and essential function in marine ecosystem maintenance (see Schedule 9 of the Intergovernmental Agreement on the Environment, Commonwealth of Australia, 1992a). A comprehensive sample of all ecosystems is required to provide an adequate sample of the ecological processes that underpin the biological diversity within any region, as well as representing the array of biological/ biophysical elements that comprise natural ecosystems.

The following steps were considered a useful broad approach for developing the National Representative System of Marine Protected Areas by the participants at a national workshop in April 1996 (Thackway 1996).

Step 1
Identify gaps in the representation of ecosystems in existing MPAs within each biogeographic region, at the meso-scale, using IMCRA; set priorities.

Step 2
Identify a list of candidate MPAs within IMCRA regions to represent major ecosystems;

Step 3
Select candidate MPAs from those listed using other criteria (cultural, social, economic and management considerations, sites of special ecological/ biological significance);

Step 4
Assess feasibility of potential reserve areas and negotiate new protected areas; and

Step 5
Establish MPAs and initiate management.

The ANZECC Task Force on Marine Protected Areas is continuing work on a project to develop a set of guidelines for identifying and selecting marine protected areas in Australia. A workshop involving representatives of government agencies, and industry, community and indigenous groups, was held in Adelaide in 1996. To further progress this project, Task Force members recently undertook to consider the applicability of guidelines already developed for the terrestrial National Reserve System. More work is required before a set of national guidelines is accepted by State and Commonwealth agencies.

5.1.3.1 Defining gaps and priorities

IMCRA can be used to identify the gaps in the current system of MPAs and to set priorities for allocating resources to fill these gaps. Similarly, IMCRA could potentially provide information regarding the level of replication. Replication is the principle that if more than one sample of an ecosystem is reserved across its geographic range this will decrease the likelihood that chance events will cause the ecosystem to decline. A suite of conservation planning attributes, which may be combined to identify broad gaps/replication levels in the current system of protected areas and set priorities for developing a NRSMPA, are under consideration.

Potential conservation planning attributes include:

- the reservation status of each meso-scale region;
- the level of bias within protected areas; that is, how comprehensively the existing protected areas in each region sample the known environmental variation;
- ecosystem integrity, that is, the health of each ecosystem in each meso-scale region;
- risks and limiting factors in establishing a viable national representative system of MPAs;
- alternative conservation planning and management measures (for example, statutory protection, planning instruments, and voluntary conservation agreements).

Three levels of priority are being considered in establishing the NRSMPA, using a combination of: level of reservation status; the level of bias in the comprehensiveness of ecosystems within MPAs; and the threatening processes:

Priority 1

- nil MPAs or low reservation status,
- nil MPAs and/or high bias in the comprehensiveness of ecosystems within MPAs, and
- threatened by current resource use activities and/or management.

Priority 2

- low to moderate reservation status,
- high to moderate bias in the comprehensiveness of ecosystems within MPAs, and
- threatened by current resource-use activities and/or management.

Priority 3

- moderate to high reservation status,
- moderate to low bias in the comprehensiveness of ecosystems within MPAs, and
- threatened by current resource use activities and/or management.

The order of these priorities reflect that the highest priority is to be given to those IMCRA meso-scale regions where there is greatest need. Second and third level priorities are allocated to lesser needs.

While IMCRA may be used for broad identification of gaps, it is not appropriate for reserve identification and selection, which must occur at a much finer scale. Similarly, IMCRA alone should not be used as the sole criterion for allocating priorities in the selection of areas for reservation.

5.1.4. Contribution towards integrated management

The marine environment is coming under increasing pressure while still trying to recover from the unsustainable practices of the past. Declining water quality, pollution, habitat loss and the introduction of exotic pests are examples of inappropriate human activity and poor management. While marine and coastal habitats are in danger of degradation, increasing numbers of people are using the sea and coastal environments for food, income and recreation.

Some of Australia's fish stocks have experienced declines over past years. Serious overfishing of southern bluefin tuna, school shark, gemfish and other species has occurred. Both fishers and fisheries managers, with the support of better science, are increasingly aware of the unintended environmental and economic impact of some practices. These include, for example, the incidental catch of other species, overfishing of target species, the impact of fishing litter and debris, distortion to predator/prey interactions and damage to habitats such as corals, sponges and seagrasses.

Fisheries management agencies are aware of the above issues and recognise the need to manage under the principles of ESD. A number of management techniques are employed in an effort to ensure sustainable harvest strategies are put in place to enhance the recovery of over fished stocks. These methods include the use of a range of input and output controls and may incorporate for appropriate species the use of MPAs or refugia.

It is expected that IMCRA will have potential for a wide range of conservation and sustainable development applications, including planning eco-tourism opportunities, ecologically sustainable development reporting, resource use, public program funding allocations and State of the Environment reporting. The recent draft report on Environmental Indicators prepared by CSIRO (1997) indicates some of the diverse ways in which IMCRA might be used in the future for State of the Environment Reporting.

5.1.5. The next level down from meso-scale regions

There is a clear need to understand the biological variation at the habitat-level or micro-scale level, not only for selecting candidate MPAs, but also to assist with coastal and marine planning and resource management. This includes information on the distribution of broadly defined habitats and understanding of species/community variation within habitats. The IMCRA meso-scale regions form an important framework for conducting this work.

5.1.5.1 Micro-scale level regionalisation

Micro-scale regionalisation requires the classification of physical and biological information to define finer scale biogeographic or ecological units. At this micro-scale level, distinct regional and local variations in habitat and biodiversity occur. These habitat variations need to be identified and classified to enable the full range of representative habitats to be encompassed within a system of Marine Protected Areas. Micro-scale regionalisation requires both the classification of local-scale variations in ecological units (i.e. habitats) and also, information on the spatial extent of these units.

Classification of marine habitats and biodiversity at the local scale, requires a spatial analysis of habitat/biodiversity information. This is generally achieved through systematic site-based marine surveys, followed by classification of the physical and biological information (into local scale ecological units) using spatial multivariate statistics (Edgar et al. 1995, Edyvane & Baker 1995, 1996).

5.1.5.2 Marine Habitat Mapping

Marine habitat mapping is an important component of micro-scale regionalisation, through defining spatial extent and boundaries of ecological units. In recent years The States and Territories, in collaboration with CSIRO Division of Marine

Research, have been undertaking a major national project to map all of continental Australia's shallow waters within three years. Landsat Thematic Mapper imagery is processed to enhance underwater features. The enhanced imagery is then taken into the field for strategic ground truth verification of features seen in the imagery. Ground truthing is used to find a position of interest or to position a site where verification takes place. Once an image has been verified the ground truth points are placed on an outline of the coast and these points placed on the image. Eight categories of habitat are used in the map but these may vary depending on where in Australia the mapping is done. The features are traced onto the image and digitised and the map presented at 1:100,000 using an ARC/INFO geographic information system. The success of this project relies on the collaboration and cooperation of State Government departments; so far extensive areas of southern Australia have been mapped.

Broadscale mapping of Australia's marine habitats and biodiversity is currently underway in many coastal regions due to an urgency to assess the current and potential impacts of aquaculture and other marine development proposals. These impacts need to be assessed in relation to the patterns of biodiversity and ecological significance of habitats, so that limits to sustainable resource development can be set.

5.1.6 IMCRA and Australia's External Territories

Australia has responsibility for sustainable resource development and biodiversity conservation in its external territories. Five provisional provinces have been described comprising Australia's islands and the Antarctic Territory (see **Map 4**). Provisional IMCRA provinces and biophysical descriptions for the Territories have been proposed (see **Table 7** and **Appendix 6**). Further work is required to review and revise this preliminary work for inclusion in Version 4.0.

5.2. Future developments of IMCRA

It is recognised that the provincial demersal and pelagic regionalisations are preliminary and require further integration within the IMCRA ecosystem-based heirarchical planning framework. Work has commenced on the development of a single provincial level regionalisation using existing information on biological and physical attributes to extend across the entire EEZ.

The revised provincial level regionalisation will be circulated to the developers of the IMCRA for review and comment. It is expected that a revised provincial level product will be available for inclusion in the next major revision of the IMCRA report.

Further refinement at the national level will also take place once State and Territory complete their habitat assessments at the scales of 1:100,000 or finer (probably in 2001/2002).

A number of other aspects, which were raised during the public consultation phase of IMCRA, will be considered for inclusion in the next version of the Report. These include:

- Minor boundary modifications may be made, such as cross Barrier Reef regions, slope waters and habitats of the continental slope and beyond the 200 nm limit or 200m isobath (e.g. Coral Sea).
- Enhanced descriptive tables as more detailed information comes available within regions. This information may relate to additional or new biota, geographic or geological data, socio-economic data, anthropogenic pressures, subsurface topography etc.
- Consideration of Catchment and Estuary management areas or IBRA regions to match the IMCRA regions or boundaries.
- IMCRA links to high resource utilisation areas (ie fishing, exploration, mining, shipping).
- A key to more technical terms to extend the use of IMCRA to non-technical users including the general public (perhaps as a special translated version—plain english , and other languages—French, Spanish, Russian and Japanese/ Chinese Indonesian for distribution to major fishing neighbours).

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7. Abbreviations

AAT	Australian Antarctic Territories
ACIUCN	Australian Committee for the World Conservation Union
AGSO	Australian Geological Survey Organisation
ANZECC	Australian and New Zealand Environment and Conservation Council
AUSLIG	Australian Surveying and Land Information Group
CNPPA	Commission on National Parks and Protected Areas (IUCN)
CONCOM	Council of Nature Conservation Ministers (now ANZECC)
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEST	Department of the Environment, Sport and Territories (Commonwealth)
EA	Environment Australia
EEZ	Exclusive Economic Zone
ERIN	Environmental Resources Information Network (EA)
GIS	Geographic Information System
IBRA	Interim Biogeographic Regionalisation for Australia
IMCRA	Interim Marine and Coastal Regionalisation for Australia
IUCN	World Conservation Union
MPA	Marine protected area
NRS	National Reserve System
NRSMPA	National Representative System of Marine Protected Areas
NSW NPWS	New South Wales National Parks and Wildlife Service
PWC NT	Parks and Wildlife Commission of the Northern Territory
SARDI	South Australian Research and Development Institute
SCC	Standing Committee on Conservation (ANZECC)
TFMPA	Task Force on Marine Protected Areas (formerly the National Advisory Committee on Marine Protected Areas)
Vic DNRE	Victorian Department of Natural Resources and Environment
WA CALM	Western Australian Department of Conservation and Land Management
WCMC	World Conservation Monitoring Centre

8. Glossary

Baseline

The baseline for measuring the breadth of the territorial sea is the low-water line along the coast as marked on large-scale charts officially recognised by Australia, except where the coastline is indented or a fringe of islands is in its immediate vicinity, in which case the method of straight baselines joining appropriate points is employed (refer to the Seas and Submerged Lands Act 1973 for Australia's baseline).

Biogeographic region

A complex area (land/sea) composed of a cluster of interacting ecosystems that are repeated in similar form throughout. Region descriptions seek to describe the dominant land/sea scape in terms of a hierarchy of interacting biophysical attributes. Biogeographic regions vary in size, with larger regions found where areas have more subdued environmental gradients. These are defined and delineated at the meso-scale.

Biotones

Zones of transition between core provinces. The biotones are not simply 'fuzzy' boundaries but represent unique transition zones between the core provinces. These biotones are unique systems and need to be recognised for their contribution to explaining the marine environment.

Conservation management measures

Conservation management measures are strategies for achieving conservation of biodiversity. Within any biogeographic region these measures may include reservation, binding legal agreements, planning instruments and voluntary conservation agreements.

Contiguous zone

A zone contiguous with (adjoining) the territorial sea, in which Australia may exercise controls relating to customs and immigration, for example. Australia's contiguous zone extends to 24 n miles from the baseline.

Continental margin

The submerged prolongation of the land mass of Australia, which consists of the seabed and subsoil of the continental shelf, slope and rise, but not the deep ocean floor.

Continental shelf

Comprises the seabed and subsoil of the submarine areas that extend beyond the territorial sea throughout the natural prolongation of the land territory to the outer edge of the continental margin where that distance is beyond 200 n miles, or to 200 n miles where the margin is less than that distance.

Ecosystem

All of the organisms in a given area in interaction with their non-living environment and each other. In practice, ecosystems are mapped and described using biophysical data. These are defined and delineated at the micro-scale or local scale.

Establishment of marine protected areas

A process of implementing reserve proposals and managing these areas for the primary purpose of biodiversity conservation. This process involves using legal or other effective means to declare and manage an area. It also involves the preparation of a plan of management which sets out how the area will be managed.

Exclusive Economic Zone (EEZ)

An area beyond and adjacent to the territorial sea, subject to the specific legal regime of Australia, under which the rights and jurisdiction of Australia and the rights and freedoms of other States are governed by the relevant provisions of the United Nations Convention on the Law of the Sea. Australia's EEZ was proclaimed in August 1994, and extends 200 n miles from the baseline.

Identification of candidate protected areas

A process used to identify a set of candidate sites/areas based on agreed targets (for example, levels of ecosystem representation within biogeographic regions), and using relevant ecological criteria as well as biological and physical data sets. It involves identifying sites/areas of key biological and ecological significance.

Inshore

The near coastal waters extending from the coastline and estuaries out to 3 n miles, which is the boundary of the State and Territory waters.

Marine protected area

Any area of estuarine, intertidal or sub-tidal terrain, together with its overlaying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment (Kelleher & Kenchington 1992).

Multiple use managed area

Multiple objective areas managed for a wide range of biodiversity conservation and other uses, such as fishing (commercial and recreational), tourism and recreation. These reserves are predicated upon the assumption that it is possible to provide for a range of uses and still protect environmental values by providing varying levels of protection and use throughout the area.

National Representative System of Marine Protected Areas

The National Representative System of Marine Protected Areas (NRSMPA) encompasses the existing marine and estuarine reserve systems that are managed and/or administered by the Commonwealth, State or Territory management agencies. It also embodies the concept of potential MPAs that are required to achieve a truly representative system of MPAs. The primary goal of the NRSMPA is representation of the full range of ecosystems found within the Australian EEZ. MPAs are to be identified within a meso-scale or regional-scale biophysical/biogeographic region.

Offshore

The area of the Exclusive Economic Zone extending from the border of the 3 n mile State and Territory waters to the limit of Australia's international marine boundary.

Protected area

An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means (CNPPA/WCMC 1994).

Selection of candidate marine protected areas

A process used to select sites/areas from the 'wish list' of areas that were identified during the identification process. The selection process involves modifying the initial set of areas to take account of socio-political, cultural and economic values.

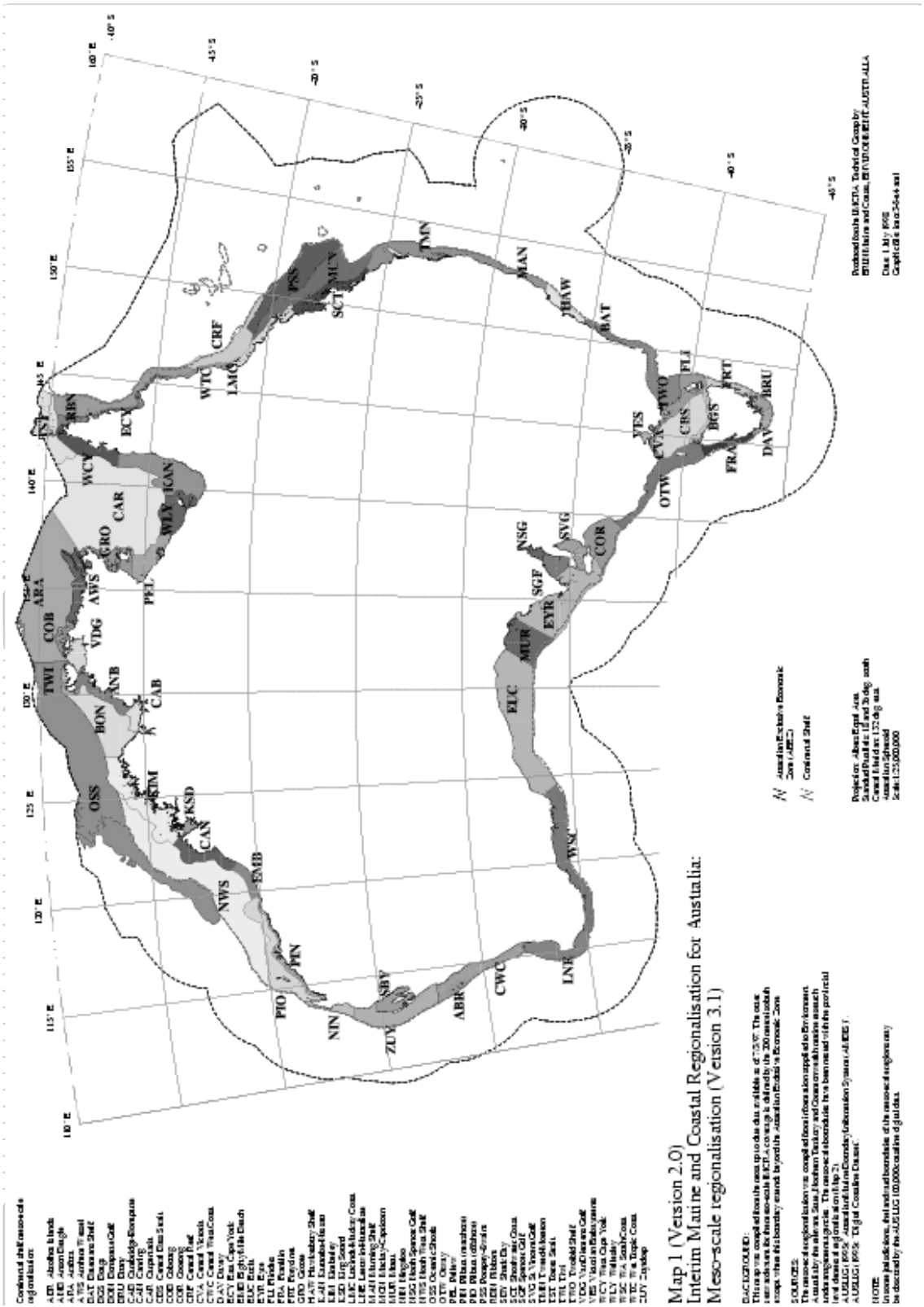
State waters

Australia's Offshore Constitutional Settlement established Commonwealth, State and Territory jurisdictions over marine areas. States generally have primary jurisdiction over marine areas to 3 n miles from the baseline. These waters are termed State waters for the purpose of this report.

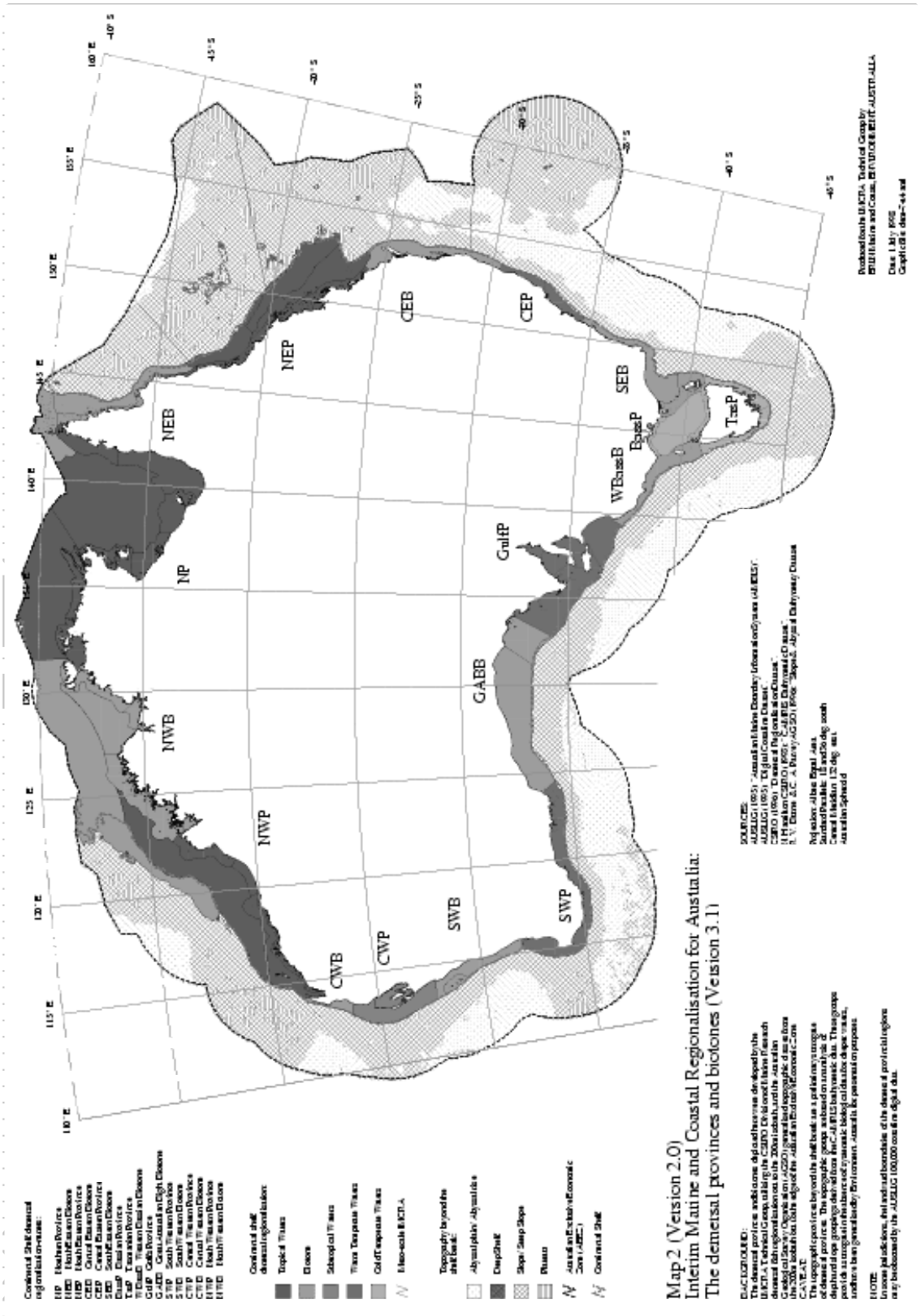
Territorial sea

The area of sea adjacent to Australia which extends beyond its land territory and internal waters. Australia's territorial sea extends 12 n miles from the baseline.

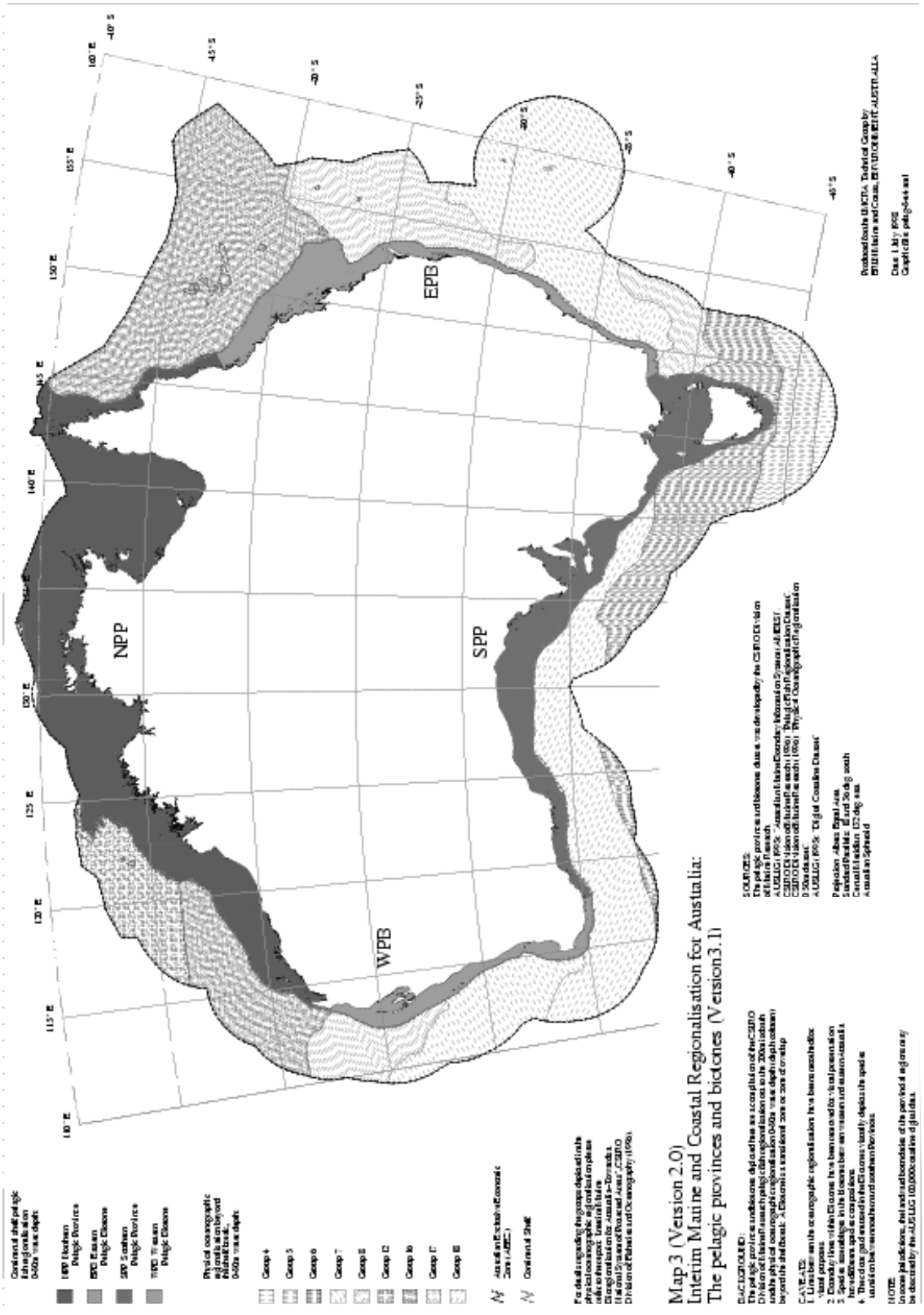
Map 1 IMCRA: Meso-scale regionalisation (Version 3.1)



Map 2 IMCRA: The demersal provinces and biotones



Map 3 IMCRA: The pelagic provinces and biotones



Map 4 IMCRA: Proposed provinces for the external territories

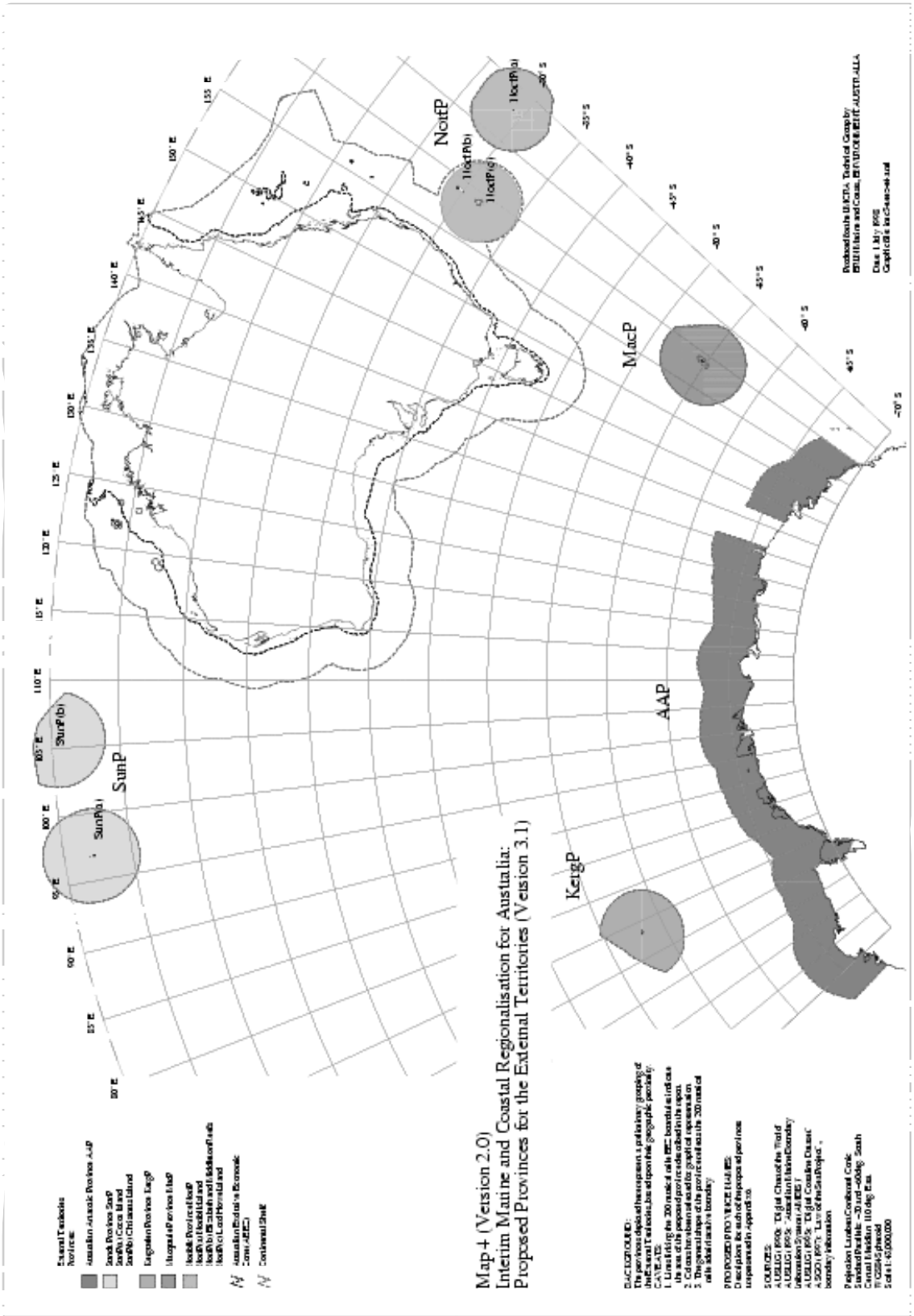


Table 1: The key stages in the development of IMCRA

March 1994	MPA Program workshop held in Sydney agrees to develop a meso-scale marine biogeographic regionalisation for Australia.
January 1995	IMCRA version 1.0 setting out an approach for developing IMCRA circulated for comment: *A proposal to develop an Interim Marine-Coastal Regionalisation of Australia (IMCRA).*
March 1995	First IMCRA technical meeting held in Sydney. State and Northern Territory marine management and research agencies agree on approach for developing the meso-scale IMCRA regionalisation. IMCRA Version 1.0 developed comprising 56 inshore regions.
November 1995	Descriptions for each meso-scale region compiled and the GIS dataset developed. IMCRA Version 1.1 circulated for comment: *An Interim Marine and Coastal Regionalisation for Australia (IMCRA), Stage 1 – the nearshore component: a framework for establishing the national system of marine protected areas.*
December 1995	Second IMCRA technical meeting held in Hobart. IMCRA Version 1.1 accepted and suggestions made for preparing Version 2.0. State, Northern Territory and Commonwealth agencies agree to develop a single regionalisation for the EEZ that would be known as IMCRA.
February 1996	Discussion paper circulated outlining an approach for integrating the regionalisations developed by inshore and offshore waters working groups. ANZECC Task Force on MPAs endorses the approach outlined.
April 1996	MPA Program workshop in Adelaide accepts the meso-scale IMCRA as the bioregional planning framework for developing a NRSMPA (see Thackway 1996). Agreement to identify gaps and set priorities for the NRSMPA based on ecosystem identification (micro-scale) within IMCRA meso-scale regions.
July 1996	Offshore waters working groups agree on a process for integrating their regionalisations with the IMCRA meso-scale regionalisation.
September 1996	IMCRA Version 2.0 circulated for comment: *Interim Marine and Coastal Regionalisation for Australia: an ecosystem-based hierarchical classification of coastal and marine environments, Stage I – The inshore waters.*
November 1996	Third IMCRA technical meeting held in Hobart. IMCRA Version 2.0 accepted and suggestions made for preparing Version 3.0, to include Commonwealth waters and External Territories. Inshore and offshore waters working groups agree on a process for integrating their regionalisation products.
March 1997	Tables and maps for Version 3.0 circulated to State, Northern Territory and Commonwealth agencies for comment. Report on progress submitted to ANZECC Standing Committee for Conservation.
December 1997 – February 1998	Public Consultation- comments included in Version 3.3.
June 1998	Endorsement of Version 3.3 by ANZECC

Table 2: Regionalisation products developed by the inshore and offshore waters working groups

Working group	Spatial coverage	Primary Scales	Primary developers	Primary regionalisations considered in the integration process
In-shore	State and Northern Territory waters	Meso	State and Northern Territory jurisdictions	• IMCRA Version 2.0 biogeographic regionalisation
Off-shore	Continental shelf and beyond the shelf break	Meso to provincial	AGSO and CSIRO Wildlife and Ecology	• Sea floor topography • Sea floor sediments* • Physical oceanographic water column* • Coastal zone geomorphology*
	Continental shelf	Provincial to meso	CSIRO Marine Laboratories	• Pelagic fish • Demersal fish
	Continental shelf and beyond the shelf break	Provincial	CSIRO Marine Laboratories	• Physical Oceanographic Water Column 0–50 m 150 m 800–1000 m

** These regionalisations were not finalised in time for the November 1996 technical meeting.*

Table 3: Descriptions of IMCRA meso-scale regions for Map 1

Region Code & Number	Region Name & State/Territory	Description *
ABR 32	Abrolhos Islands WA	**Location:** State waters around the islands. **Remarks:** Shelf-edge complex comprising a series of four dissected limestone platforms and islands with extensive coral reef development.
ANB 18	Anson-Beagle NT	**Location:** Inshore waters of the western Top End coast from Pearce Point to Cape Hotham, including the Beagle Gulf and the southern shores of Melville and Bathurst Islands between the High Water Mark and the 30 m isobath. **Remarks:** Coastline can be categorised into two distinct types: (1) In the south, exposed north-west facing sandy coasts with scattered low lateritic cliffs; and (2) In the Darwin/Bynoe Harbour area drowned river valleys (ria shoreline) with extensive intertidal mudflats. Mangroves are concentrated in extensive stands in the Adelaide River delta, Darwin Harbour and Bynoe Harbour, with narrow strips fringing Anson Bay and Fog Bay. Waters generally turbid due to dominance of fine terrigenous sands and muds, macrotidal range (to 8m) and Wet season sediment input from the Daly, Finniss and Adelaide Rivers.
ARA 20	Arafura NT	**Location:** Arafura Sea to the limit of the EEZ, in waters deeper than the 30 m isobath, along the Territory coast from the English Company Islands to Melville Island. **Remarks:** The seafloor slopes gently north-west and has generally low relief. Bottom features are mainly submerged strandlines between 80–200 m depth, islands in the east (Wessel Islands). Terrigenous sediments are restricted to inshore: they are transgressive, with coarse shelly quartz sand grading seawards into silty clay. Offshore, relict Pleistocene sediments dominate. Biological knowledge of the area is poor.
AWS 15	Arnhem-Wessel NT	**Location:** Arnhem Land coast from Turner Point to Cape Wilberforce from the High Water Mark to the 30 m isobath. **Remarks:** Complex coastline encompassing a variety of bays, inlets, rivers and islands. Tidal range generally increases eastwards from 3 m to 5 m at Arnhem Bay. Coasts with northerly or easterly exposures generally consist of bare rock or sand barriers and mangrove is absent or restricted between and behind sand ridges. Deeper bays are sufficiently sheltered for greater mangrove development. Alluvial and estuarine plains present, some supporting sparse saltmarsh. Coral reefs generally absent except for fringing reefs off the Wessel and English Company Islands.
BAT 53	Batemans Shelf NSW	**Location:** North of Tathra to Shellharbour (34°35′). **Remarks:** Southern NSW invertebrate assemblage.
BGS 45	Boags TAS	**Location**: Near Kangaroo Island to Tree Point (Little Musselroe Bay). **Remarks:** Sheltered open coastline with long sandy beaches broken by rocky headlands that extend under sand in relatively shallow depths (normally < 20 m). High tidal range ≈ 3 m.
BON 19	Bonaparte Gulf NT	**Location:** Bonaparte Basin in waters deeper than the 30 m isobath north to the reef complexes of the Oceanic Shoals (OSS) Region. **Remarks:** Sediments are dominated by biogenic gravels and sands grading to biogenic muds offshore. Subsurface sediments are highly prospective for petroleum. Biological knowledge of the area is poor, except for trawl by-catch data which indicates that fish assemblages are distinctly different from those of the Arafura (ARA) Region to the east.
BRU 47	Bruny TAS	**Location:** Cape Bernier to Southport. **Remarks:** Highly-dissected coastline with extensive embayments protected from submaximal swell by islands and peninsulas. Low tidal range ≈ 1 m. Endemic plants and animals.

** Areas of each Region are given in Table 6.*

Table 3: Descriptions of IMCRA meso-scale regions for Map 1 continued

Region Code & Number	Region Name & State/Territory	Description *
CAB 21	Cambridge-Bonaparte NT/WA	**Location:** Cambridge and Bonaparte Gulfs from Cape Dussejour (WA) to Pearce Point (NT) from the High Water Mark to the 30 m depth contour. **Remarks:** Comprises the headwaters of Joseph Bonaparte Gulf, a broad, open marine gulf straddling the WA/NT border. At its head are two major seasonal estuarine systems—Cambridge Gulf (Ord, Pentecost and Durack Rivers) on the WA side, and a complex of three estuaries (Keep, Victoria and Fitzmaurice Rivers) on the NT side. They are separated by stretches of low-profile shore, backed by salt flats.
CAN 24	Canning WA	**Location:** West of Cape Leveque to Cape Missiessy including the Lacepede Islands. **Remarks:** The northern part of the Canning Basin shore. Southern part comprises Eighty Mile Beach. Alternating embayments and headlands with very large tidal range. Little or no fluvial run-off.
CAR 12	Carpentaria NT	**Location:** Gulf of Carpentaria to the limit of the EEZ in waters deeper than 30 m. **Remarks:** Extensive fairly shallow (<70 m) offshore region of the Gulf of Carpentaria. Generally poorly known except from the point of view of commercial fisheries. Mostly muddy substrate, less so towards the east. High cyclone incidence.
CBS 51	Central Bass Strait SA/VIC/TAS	**Location:** Central Bass Strait (offshore). **Remarks:** The region is about 60,000 km^2 in size and lies in the central area of Bass Strait. The sea floor is shaped like an irregular saucer with water depth varying from about 80 m at its centre to 50 m around the margins. The substrate of central area is mainly mud. Tidal velocities vary from <0.05 ms^{-1} in the central area to as high as 0.5 ms^{-1} at the margins where the islands and promontories form the western and eastern entrances to Bass Strait. Water mass characteristics are complex and vary seasonally representing the mixing of the different water masses present on western and eastern side of the Strait.
COB 58	Cobourg NT	**Location:** Cape Don to Turner Point, and seaward from the High Water Mark to the 30 m isobath. Includes the northern side of Cobourg Peninsula and Croker and Goulburn Islands. **Remarks:** Coast of numerous bays and inlets lined by sandy beaches. Lack of rivers with small tidal range (2–3 m) infers minimal sediment debouchment and relatively low turbidity throughout the region. Mangroves restricted to narrow strips along bays and creek inlets. Numerous fringing reefs throughout entire region.
COR 43	Coorong SA	**Location:** Cape Jaffa to Cape Jervis. **Remarks:** Offshore gradient decreases from steep to flat resulting in a gradational coastline change from high to low energy. Microtidal ~ 0.8 to 1.2 m range. Precambrian crystalline rock and metasediment headlands and cliffs. Pleistocene dune rock cliffs, headlands, shore platforms and reefs. Holocene pocket beaches and an extensive beach-dune barrier lagoon complex. Cool temperate waters.
CRF 5	Central Reef QLD	**Location:** Mid-shelf and offshore reefs from Cruiser Pass to mid-shelf north of Bowen, extending to offshore reefs north of the Hard Line. **Remarks:** Offshore region including the mid- and outer-continental shelf characterised by mostly sandy sediments of carbonate origin with some mud content in midshelf areas. Reefs in earlier stages of development, poorly developed at the shelf margin.

** Areas of each Region are given in Table 6.*

Table 3: Descriptions of IMCRA meso-scale regions for Map 1 continued

Region Code & Number	Region Name & State/Territory	Description *
CVA 50	Central Victoria VIC	**Location:** Cape Otway to west of Wilsons Promontory. **Remarks:** Very steep to steep offshore gradients dominated by cliffed shorelines. Sea-surface temperature is representative of Bass Strait waters. Moderate wave energy.
CWC 33	Central West Coast WA	**Location:** Kalbarri to Perth. **Remarks:** Relatively narrow continental shelf with diverse moderate energy coastal landforms. Includes one of the largest temperate limestone reef systems in Australia.
DAV 46	Davey TAS	**Location:** Southport to Svenor Point. **Remarks:** Very exposed coastline with extensive rocky headlands separated by short sandy beaches. Low tidal range ≈ 1 m. Biotically depauperate. Cold water.
ECY 8	East Cape York QLD	**Location:** Eastern coast of Cape York, from the northern tip to approximately Cooktown. **Remarks:** Relatively dry inshore coastal region characterised by lower littoral faunal diversity than adjacent regions, muddy-sand substrates and extensive shoals, planar and lagoonal reefs, low wooded cays.
EMB 25	Eighty Mile Beach WA	**Location:** Cape Missiessy to Cape Keraurdren. **Remarks:** Almost continuous curving beach of siliceous sand, on average 100 m wide. Important migratory shorebird habitat and designated under RAMSAR Convention as a Wetland of International Importance.
EUC 37	Eucla WA/SA	**Location:** Cape Adieu to Israelite Bay. **Remarks:** Shallow offshore gradient. Approx. 0.8 to 1.2 m tidal range. Open, moderate energy, west facing coastline. High Nullarbor tertiary limestone cliffs, Pleistocene dune rock headlands and reefs, Holocene beaches and dune barriers. Warm temperate water influenced by periodic intrusion of the Leeuwin current.
EYR 39	Eyre SA	**Location:** Point Brown to Cape Torrens, to West Cape, to Port Neill and Cape Willoughby. **Remarks:** Shallow to moderate offshore gradients. Moderate to high energy coastline. Pleistocene dune rock cliffs, headlands and shore platforms. Microtidal ~ 0.8 to 1.2 m range. Holocene dune barriers, beaches and lagoon deposits. Precambrian metasediment cliffs. Cainozoic colluvial and fluvial sediments. Cool temperate water subject to nutrient rich upwellings.
FLI 49	Flinders TAS/VIC	**Location:** Eastern Entrance to Bass Strait and including Wilsons Promontory, Flinders Island and other islands (but not the Kent Group). **Remarks:** Rapid changes in offshore gradient. Granitic coastline exposed to submaximal swells on east-facing shores of Flinders Island and moderate to low swells elsewhere. Sandy beaches of moderate length with seagrass beds prevalent in shallow water. High tidal range ≈ 3 m and strong tidal currents. Sea-surface temperature is representative of Bass Strait waters. Waves highly variable.
FRA 57	Franklin TAS	**Location:** Svenor Point to Cape Grim. **Remarks:** Extremely exposed open coastline with long sandy beaches broken by rocky headlands. Moderate tidal range ≈1.5 m.
FRT 48	Freycinet TAS	**Location:** Tree Point to Cape Bernier. **Remarks:** Submaximally exposed coastline with approximately equal areas of rocky headland and sandy beach, and numerous coastal lagoons. Moderate tidal range ≈ 1.5 m. Cool water, sub-tropical convergence.

** Areas of each Region are given in Table 6.*

Table 3: Descriptions of IMCRA meso-scale regions for Map 1 continued

Region Code & Number	Region Name & State/Territory	Description *
GRO 14	Groote NT	**Location:** Inshore along the north-east Arnhem Land coast from Cape Wilberforce to Nyinpinti Point, from High Water Mark to the 30 m isobath, including Groote Eylandt and associated Islands. **Remarks:** Rocky dominated shoreline. Coastline mainly of large parabolic dune systems formed by predominant south-easterly winds. Mangroves restricted to narrow strips along creeks and lagoons, apart from Blue Mud Bay which is sheltered and supports extensive mangroves and mudflats. Coral reefs absent except for parts of Groote Eylandt, particularly north-western region. Tidal range microtidal with a maximum range of 2 m.
HAW 54	Hawkesbury Shelf NSW	**Location:** Shellharbour to Stockton (32°54′S). **Remarks:** Southern NSW fish and algal assemblage. Mid south coast invertebrate assemblage.
KAN 11	Karumba-Nassau QLD	**Location:** Just north of Cape Keerweer to Albert River, seaward to the 40 m isobath. **Remarks:** Inshore-coastal region characterised by relatively low diversity mangrove forests, extensive saltpans (seasonally inundated), a single tidal cycle and sandy substrates in subtidal areas. Monsoonal influence.
KIM 22	Kimberley WA	**Location:** Cape Londonderry to west of Cape Leveque, including Buccaneer Archipelago. **Remarks:** This is a remote and little-studied section of the coast, characterised by rocky shore, mud flat, mangal and land-locked marine and estuarine habitats. A broad area of the inner shelf is included within the WA State Territorial Waters because the baseline is located seaward of the many nearshore islands. Buccaneer Archipelago is included in this region. Rainfall is high in the north but decreases south of Walcott Inlet.
KSD 23	King Sound WA	**Location:** King Sound, south of Point Osborne and Shenton Bluff. **Remarks:** This wide, open gulf encompasses the seasonal Fitzroy Estuary and Stokes Bay.
LMC 4	Lucinda–Mackay Coast QLD	**Location:** Coastal and island waters from Lucinda to approximately Mackay, including the Whitsunday and Cumberland groups. **Remarks:** Inshore coastal region including complex high-island groups (Whitsundays and Cumberlands), sandy-mud substrates, less complex and diverse mangrove communities and lower littoral faunal diversity than regions to the north. Large tidal range, especially in the south.
LNE 34	Leeuwin-Naturaliste WA	**Location:** Perth to Black Head. **Remarks:** High energy, heavy swell affected shore. Narrow continental coast. Cold inshore current running counter to the warm off-shore Leeuwin Current. Multiple granitic, doleritic or gneissic headlands interspersed with lunate bays.
MAN 55	Manning Shelf NSW	**Location:** Stockton to north of Nambucca Heads (30°39′S). **Remarks:** Distinctive algal assemblage. Only 21 species of hard corals.
MCN 3	Mackay-Capricorn QLD	**Location:** Mid-shelf waters and reefs from seaward of the Whitsundays, south to Lady Elliott Island. **Remarks:** Offshore region comprising the central portion of the very broad continental shelf, characterised by mostly mud and sandy-mud substrates associated with an extensive drowned river valley. Fauna very poorly known, deep water forms. Few reefs or islands except Capricorn-Bunker group in the south. Extensive submerged reefs and shoals.
MUR 38	Murat SA	**Location:** Point Brown to Cape Adieu. **Remarks:** Shallow offshore gradient. Moderate to low energy coastline. Microtidal ~ 0.8 to 1.2 m range. Crenulate bays due to Precambrian crystalline rock headlands usually with a dune rock capping. Pleistocene dune rock cliffs, reefs and headlands. Holocene beaches, dunes and estuarine deposits including intertidal and supratidal flats. Offshore islands and seamounts. Warm temperate waters. Leeuwin current.

** Areas of each Region are given in Table 6.*

Table 3: Descriptions of IMCRA meso-scale regions for Map 1 continued

Region Code & Number	Region Name & State/Territory	Description *
NIN 29	Ningaloo WA	**Location:** North West Cape to Gnaraloo Bay. **Remarks:** One of Australia's major coral reef systems of great complexity with a species-rich coral reef community. Continuous offshore in the north and interrupted fringing in the south.
NSG 40	North Spencer Gulf SA	**Location:** Point Riley to Port Augusta to Shoalwater Point. **Remarks:** Confined, inverse estuary with minimal land water input. Shallow offshore gradients. Low energy shorelines. Micro to mesotidal ~1.8 to 3.6 m range. Precambrian metasediment shore platforms. Holocene sandflats, beach ridges, recurved spits, and extensive intertidal and supratidal flats. Warm temperate waters with a subtropical biotic element.
NWS 28	North West Shelf WA	**Location:** Outer part of the North West Shelf. **Remarks:** The outer part of the North West Shelf, lying between about the 30 m bathymetric contour and the shelf edge, is an oceanic region off the Pilbara and Kimberley coasts. This region has diverse benthic invertebrate communities and fish fauna.
OSS 60	Oceanic Shoals WA/NT	**Location:** An area of submerged and emergent reefs and cays along the outer edge of the continental shelf and inshore to the mainland, extending from the Lyndoch and Troubadour Shoals in the Arafura Sea north of Darwin, to the Rowley Shoals north-west of Broome. This region also includes a number of banks and reef systems closer inshore, including the Sahul Shelf, an extensive submerged feature of complex channels, terraces and flat-topped banks. The limits of this region are nominated as lying between 18° South and 119° East, and 10° 30′ South and 131° East. **Remarks:** This offshore area contains a number of active shelf-edge platform reef systems in the Timor and Arafura Seas, while in the north along the edge of the Timor Trench in the north-eastern Indian Ocean, there are a number of submerged or drowned reefs which may once have constituted an intermittent barrier reef prior to being buried by rising sea levels and sedimentation. Evidence obtained from core samples from oil exploration drilling undertaken in this area, indicates that there has been long term subsidence of the continental slope and shelf edge, associated with the collision of the Asian and Australian blocks. To the south-west, the subsidence of the shelf edge has been less dramatic and the Seringapatam, Scott Reef and Rowley Shoals reef systems persist as a disjunct line of near surface or emergent reefs. Other in-shore reefs and islands such as Browse, Adele and Lynher which are within WA State waters, are included in this region.
OTW 44	Otway SA/VIC/TAS	**Location:** Cape Jaffa to slightly north of Apollo Bay and including King Island environs. (Narrow band across the western entrance of Bass Strait.). **Remarks:** Very steep to moderate offshore gradients. High wave energy. Currents generally slow, but moderately strong through entrance to Bass Strait. Cold temperate waters subject to nutrient rich upwellings.
PEL 13	Pellew NT	**Location:** Inshore along the gulf of Carpentaria coast from Nyinpinti Point to the Albert River from High Water Mark to the 30 m isobath. **Remarks:** Coastline of alluvial plains, composed of clays and muds in varying proportions. On these shores mangroves can be regarded as continuous, extending up to 1 km inshore in parts. Coral reefs entirely absent. Tidal range increases to a maximum of 3 m.
PIN 26	Pilbara (nearshore) WA	**Location:** Nearshore (to 10 m depth) from Cape Keraurdren to North West Cape. **Remarks:** High diversity of in-fauna from intertidal mudflats and sandflats associated with fringing mangals in bays and lagoons. Highly turbid water associated with large tidal range. Fringing coral reefs around some of the islands.

** Areas of each Region are given in Table 6.*

Table 3: Descriptions of IMCRA meso-scale regions for Map 1 continued

Region Code & Number	Region Name & State/Territory	Description *
PIO 27	Pilbara (offshore) WA	**Location:** Waters seaward of 10 m depth contour between North West Cape and the Monte Bello Islands. **Remarks:** Beyond the 10 m bathymetric contour in the west Pilbara; the ocean water is less turbid than that of the inshore area and there are significant differences in marine ecosystems. Includes coral reef ecosystems with Indonesian and Pacific affinities.
PSS 2	Pompey-Swains QLD	**Location:** Offshore reefs seaward of Whitsundays to the Swain Reefs, including Hard Line, Pompey and associated reef complexes. **Remarks:** Offshore region comprised mostly of very complex and extensive planar and lagoonal reef systems, sandy sediments of carbonate origin. Fauna otherwise poorly known. A few isolated sand cays.
RBN 7	Ribbons QLD	**Location:** Offshore east Cape York, from north of Yule Entrance to the southern extent of the ribbon reefs at Cruiser Pass. Remarks: Offshore region extending to the edge of the continental shelf, eastern margin comprised of ribbon reefs and detached reef complexes, with small, poorly developed reefs behind. Sandy sediments of carbonate origin.
SBY 31	Shark Bay WA	**Location:** Inner waters south of Cape Ronsard on Bernier Island. **Remarks:** World Heritage Area. The only major embayment between Exmouth Gulf and Cockburn Sound. Contains among the world's most extensive seagrass meadows and calcareous sand banks which provide habitat for rich communities of macrophytic algae, fishes and invertebrates. Stromatolites occur in a modern sedimentary embayment. Worlds largest dugong population. Historically important in terms of Australia's marine science.
SCT 1	Shoalwater Coast QLD	**Location:** Coastal and island waters from Mackay to just north of Port of Battle Creek. **Remarks:** Inshore coastal region comprising large bays with very large tidal range, large coastal islands, mostly sandy substrates, little terrestrial input due to relatively (in comparison to neighbouring areas) low rainfall. Less extensive and complex mangrove forests, less diverse littoral fauna than regions to the north.
SGF 41	Spencer Gulf SA	**Location:** West Cape to Port Neill, Point Riley to Shoalwater Point. **Remarks:** Semi-confined. Shallow offshore gradients. Low to moderate energy shorelines. Microtidal ~1.8 m range. Precambrian crystalline rock headlands forming embayments. Cainozoic outwash sediments forming low cliffs. Holocene beaches, dunes and estuarine deposits. Warm temperate waters.
SVG 42	St Vincent Gulf SA	**Location:** Cape Torrens to West Cape, Cape Jervis to Cape Willoughby. **Remarks:** Confined inverse estuary. Shallow offshore gradients. Low to moderate energy coastline. Micro to mesotidal ~1.2 to 3.3 m range. Precambrian metasediment and Tertiary cliffs. Holocene beaches, sandflats, dunes, beach ridges, estuarine deposits, extensive intertidal and supratidal flats. Warm temperate waters.
TMN 56	Tweed-Moreton NSW/QLD	**Location:** Coastal and estuarine waters from north of Nambucca Heads to just north of Port of Battle Creek. **Remarks:** Inshore coastal region comprising narrow continental shelf. Characterised by extensive sandy beaches interspersed with rocky headlands. Sediments of terrestrial origin, also extensive estuaries formed behind sand islands. Occasional sandstone outcrops form substrates for reefal faunas. Towards the southern limit of hard corals, and has a distinctive algal species assemblage. Significant difference in occurrences of seagrass species between Queensland and NSW southern boundary, near Coffs Harbour. Offshore sand barrier islands. Offshore benthic fauna not well known.

** Areas of each Region are given in Table 6.*

Table 3: Descriptions of IMCRA meso-scale regions for Map 1 continued

Region Code & Number	Region Name & State/Territory	Description *
TST 9	Torres Strait QLD	**Location:** Torres Strait from the Warrior Reefs, west to the 40 m isobath, including Moa and Badu islands. **Remarks:** A complex shallow region with extensive shoals, banks and reefs, extensive seagrass beds. Biology poorly known except commercial fisheries. A mixing zone for waters from the coral sea and Indonesia; major sediment and nutrient enrichment (and some heavy metal movement) from Papua New Guinea rivers. The Fly River in particular contributes to these waters in a relatively narrow band along the Papua New Guinea coastline with very limited apparent mixing with central and southern Torres Strait waters. There are major anthropogenic impacts adjacent to Horn and Thursday Islands. Extremely strong currents and complex tidal regime. Low cyclone incidence.
TWI 16	Tiwi NT	**Location:** Northern coasts of the Tiwi Islands from Point Fawcett to Soldier Point from the High Water Mark to the 30 m isobath, and including Apsley Strait. **Remarks:** Northern coasts consisting of numerous, deeply indented bays and inlets. Extensive areas of mangrove in sheltered inlets and creeks. Intermittent fringing reefs occur off prominent headlands.
TWO 52	Twofold Shelf VIC/NSW/TAS	**Location:**East of Wilsons Promontory and north to Tathra (36°48′S), including the Kent Group of islands (around 39°25′S). **Remarks:** Submaximally exposed coastline with long sandy beaches broken by rocky headlands and numerous coastal lagoons. Moderate tidal range ~ 2 m. Mean annual sea-surface temperature reflects the influence of warmer waters brought into Bass Strait by the East Australian Current. Variable wave energy.
VDG 17	Van Diemen Gulf NT	**Location:** Includes all waters of Van Diemen Gulf. Western boundary a line from Cape Hotham to Muranapi Point, northern boundary a line from Soldier Point to Cape Don. **Remarks:** Region includes the entirety of the Van Dieman Gulf. Coastline can be categorised into two types: (1) low, flat, alluvial, deltaic estuarine floodplains, with associated chenier dunes and narrow mangrove fringes, particularly in the south; (2) intermittent fringing reefs backed by well developed mangrove forests along the coasts of the Cobourg Peninsula and Melville Island. Waters always turbid due to dominance by fine terrigenous sediments, macrotidal range (4-6m) shallow water depths, and Wet season input from the Mary River and the Alligator rivers system.
VES 59	Victorian Embayments VIC	**Location:** Victorian bays, inlets and estuaries. **Remarks:** Confined bodies of water that total in excess of 3000 km^2 and individually vary in size from 1950 km^2 to less than 1 km^2. They are generally basin-shaped, less than 25 m deep, have limited fetch and are dominated by depositional environments.
WCY 10	West Cape York QLD	**Location:** Western coast of Cape York, from just north of Cape Keerweer to the northern tip, including Thursday Island group. **Remarks:** Inshore coastal region characterised by significant freshwater input from coastal wetlands, dual tidal cycle and distinctive mangrove and salt marsh assemblages and fauna. Generally sandy substrates subtidally, except at river mouths. Low cyclone incidence.
WLY 35	Wellesley QLD	**Location:** Albert River to Calvert River, seaward to the 40 m isobath. **Remarks:** Coastal and island region encompassing and dominated by the Wellesley Island Group. Structurally significant coral reefs, especially on the northern side of Mornington Island, comprising the only significant reefs in the southern Gulf of Carpentaria. The area is subjected to extensive inundation from monsoonal rains and storm surges in the wet season, and for the most part has only one tide per day. The adjacent mainland coastline is comprised of eroding sandy-mud intertidal flats.

** Areas of each Region are given in Table 6.*

Table 3: Descriptions of IMCRA meso-scale regions for Map 1 continued

Region Code & Number	Region Name & State/Territory	Description *
WSC 36	WA South Coast WA	**Location**: Black Head to Israelite Bay. **Remarks**: Extensive seagrass meadows in embayments and inlets. Limestone cliffs over 300 m high. High energy ruggedly scenic coastline.
WTC 6	Wet Tropic Coast QLD	**Location**: Coastal and island waters from approximately Cooktown to Lucinda, including Hinchinbrook Island. **Remarks**: Inshore coastal region dominated by very complex and extensive mangrove forests and very high littoral faunal diversity. Sediments very muddy, of terrestrial origin, from very high but seasonal rainfall. Poorly developed inner shelf reefs.
ZUY 30	Zuytdorp WA	**Location**: Gnaraloo Bay to Kalbarri, but not including Shark Bay. **Remarks**: (1) Mainland coast north of Carnarvon, (2) western sides of the outer Shark Bay islands and Edel Land Peninsula, and (3) Kalbarri cliffs. High energy rocky shores with high limestone cliffs and narrow fringing reefs exposed to heavy wave action.

** Areas of each Region are given in Table 6.*

Table 4: Descriptions of IMCRA demersal provinces and biotones for Map 2

Code	Province/ Biotone Name	Description
BassP	Bassian Province	**Area:** 70,630 km^2 **Location:** Comprising the core of Bass Strait flanked by King Island in the west and the Furneaux and Kent Group of islands in the east. The north-western margin is just east of Cape Otway and extends to Waratah Bay. The southern limits extend along the Tasmanian coast from near Kangaroo Island to Tree Point (Little Musselroe Bay). **Remarks:** A weak province defined by a small suite of narrow-ranging, endemic species confined to Bass Strait and adjacent biotones, superimposed on a strong biotone where warm temperate elements from the Central Eastern Province (CEP), South Western Province (SWP), cool temperate elements (TasP), and widespread southern temperate species mix. The region is recognised on the basis of its small but unique indicator group that is important from a biodiversity conservation perspective. **Meso-scale regions:** Includes Victorian Embayments, Central Victoria, Central Bass Strait and Boags regions.
CEP	Central Eastern Province	**Area:** 22,800 km^2 **Location:** From just south of Coffs Harbour to south of Wollongong. **Remarks:** Strong province coincident with the central portion of the Peronian Province (Whitley, 1937) and consisting mainly of eastern warm temperate/subtropical species. Indicator species typically extend from the Central Eastern Biotone (CEB) to the South Eastern Biotone (SEB). Penetrated by tropical eastern Australian elements, many of which occur extralimitally as juveniles at the southern margin of the Province. Also north-eastern limit of large suite of widespread southern temperate species that extend west to the South Western Biotone (SWB). Units of this province are well represented in the Norfolk Province (NorfP). **Meso-scale regions:** Includes Hawkesbury Shelf and Manning Shelf regions.
CEB	Central Eastern Biotone	**Area:** 60,670 km^2 **Location:** From just north of Port of Battle Creek to just south of Coffs Harbour in the south, and including the eastern-most point of the Australian mainland. **Remarks:** The biotone is structurally dominated by elements of the North Eastern Province (NEP) and Central Eastern Province (CEP). A large suite of eurythermal, widespread southern temperate species, that originate from the Central Western Province (CWP) and South Western Biotone (SWB), extend northward into this biotone. It is characterised by a series of strong internal disjunctions that are likely to represent meso-scale structuring. The main disjunctions occur between Gladstone and Bundaberg where the southward ranges of a suite of tropical species end. Another disjunction occurs in the region between Hervey Bay and Maroochydore where the northward ranges of a suite of temperate species end. The southern limit of this biotone also coincides with a major disjunction between tropical and warm temperate species. **Meso-scale regions:** Tweed-Moreton region.

Table 4: Descriptions of IMCRA demersal provinces and biotones for Map 2 continued

Code	Province/ Biotone Name	Description
CWB	Central Western Biotone	**Area:** 27,370 km^2 **Location:** From Gnaraloo Bay to just north of North West Cape in the north. Remarks: Major zone of overlap between temperate and subtropical species, elements of the North Western Province (NWP), and a suite of wide ranging tropical Indo–West Pacific species. Temperate elements are dominated by subtropical Central Western Province (CWP) species and some South Western Province (SWP) species. North-western limit of a suite of widespread, eurythermal southern Australian species that extend east to the Central Eastern Province (CEP) and Central Eastern Biotone (CEB). **Meso-scale regions:** Ningaloo region.
CWP	Central Western Province	**Area:** 40,250 km^2 **Location:** From approximately Geraldton in the south to Gnaraloo Bay in the north. **Remarks:** Defined by a suite of subtropical species that extend from the South Western Biotone (SWB) and western sector of the South Western Province (SWP), to the Central Western Biotone (CWB) and southern limits of the North Western Province (NWP). This faunal unit has been recognised by Hutchins (1994). It represents the southern part of Whitley's (1937) Dampierian Province. **Meso-scale regions:** Includes Shark Bay and Zuytdorp regions.
GABB	Great Australian Bight Biotone	**Area:** 200,000 km^2 **Location:** Great Australian Bight from Israelite Bay in the west to Point Brown in the east. **Remarks:** Weak biotone dominated by species from the South Western Province (SWP), with a few elements of the Gulf Province (GulfP). A major disjunction exits near the Recherche Archipelago corresponding to the western limits of a suite of wide-ranging species from the Central Eastern (CEP) and Tasmanian Provinces (TasP), and the eastern limits of the South Western Province (SWP). The biotone is also traversed by a large suite of wide-ranging, western, warm temperate species that extend along the southern Australian coast to the Gulf Provinces (GulfP), Bassian Province (BassP) and the South Eastern Biotone (SEB), and a suite of ubiquitous temperate Australian species that originate in the Central Eastern Province and Biotone (CEP and CEB). **Meso-scale regions:** Includes Eucla and Murat regions.
GulfP	Gulfs Province	**Area:** 35,379 km^2 **Location:** Comprising the Gulfs of Spencer and St Vincent and enclosing Kangaroo Island. Extends out to the shelf break with a western boundary at Point Brown and an eastern edge at Cape Jervis. **Remarks:** A weak but unique province with a small endemic element and subtropical relict species. It has a strong disjunction near its northern boundary and acts as a major biotone for cool temperate species (TasP and BassP) and for a large suite of species from the South Western Province (SWP). The hypersaline and sub-tropical temperature conditions in the Gulfs are unique within temperate Australia and probably enable this region to act as a refugia for warmer water species. Once again, the unique relict nature of the region makes it worthy of recognition from a conservation standpoint. **Meso-scale regions:** Includes Eyre, North Spencer Gulf, Spencer Gulf and St Vincent Gulf regions.

Table 4: Descriptions of IMCRA demersal provinces and biotones for Map 2 continued

Code	Province/ Biotone Name	Description
NEB	North Eastern Biotone	**Area:** 125,100 km^2 **Location:** Extending from west of Cape York to Cooktown/Cairns. **Remarks:** Zone of faunal overlap defined by a very strong disjunction at Cape York. Consists of the northern limit of a small suite of tropical eastern endemics from the North Eastern Province (NEP) and the eastern limit of a large suite of widespread, tropical Indo–West Pacific species whose distributions originate well west of the Northern Province (NP) and North Western Biotone (NWB). **Meso-scale regions:** Includes Torres Strait, Ribbons and East Cape York regions.
NEP	North Eastern Province	**Area:** 144,000 km^2 **Location:** From Cooktown/Cairns to just north of Port of Battle Creek enclosing the southern portion of the Great Barrier Reef. **Remarks:** Defined by Eastern tropical endemics extending from the North Eastern Biotone (NEB) to the Central Eastern Biotone (CEB). Few provincial species extend southward beyond the South Eastern Biotone (SEB). Conforms with the Banksian Province of Whitley (1937). Pacific coral reef species are better represented in this provinces than any other. **Meso-scale regions:** Includes Wet Tropic Coast, Shoalwater Coast, Mackay-Capricorn, Pompey-Swains, Lucinda–Mackay Coast, and Central Reef regions.
NP	Northern Province	**Area:** 805,000 km^2 **Location:** Extending from east of Cape Hotham to west of Cape York. **Remarks:** This Province represents a core area traversed by a large suite of tropical Indo–West Pacific fishes whose ranges extend variably down the eastern and western Australian coasts. It is not demarcated by an obvious suite of indicator species. The Gulf of Carpentaria is represented by a comparatively simple range of habitats (i.e. coral reef habitats and their faunas are poorly represented) that may contain unique faunal elements that so far remain undefined. A weak disjunction exists at Gove (north-western tip of Gulf of Carpentaria) possibly indicating a boundary at the meso-scale level. It is bounded in the east by a major faunal disjunction and the North Eastern Biotone (NEB). Further work is needed to evaluate substructure within this Province and adjacent biotones. **Meso-scale regions:** Includes West Cape York, Wellesly, Karumba-Nassau, Pellew, Carpentaria, Groote, Arafura, Arnhem Wessel and Cobourg regions.
NWB	North Western Biotone	**Area:** 380,900 km^2 **Location:** From west of Cape Leveque to east of Cape Hotham. **Remarks:** Weak biotone with some mixing of elements of the Northern Province (NP) that extend across to the North Eastern Biotone (NEB) and North Eastern Province (NEP), and wide-ranging species of the North Western (NWP) and Central Western Provinces (CWP). Also transgressed by dominant suites of widespread tropical elements. **Meso-scale regions:** Includes Tiwi, North West Shelf, Anson Beagle, Cambridge-Bonaparte, Bonaparte Gulf, Van Diemens Gulf, Kimberley, King Sound and Oceanic Shoals regions.

Table 4: Descriptions of IMCRA demersal provinces and biotones for Map 2 continued

Code	Province/ Biotone Name	Description
NWP	North Western Province	**Area:** 156,400 km^2 **Location:** Extending from just north of North West Cape to west of Cape Leveque. **Remarks:** Provincial region consisting of a large suite of widespread tropical species and a small provincial suite with their southern limits mainly in the Central Western Biotone (CWB) but sometimes further south. Weak disjunction occurs near Broome with some species extending north to Melville Island. It includes offshore tropical atolls and represents the central part of Whitley's Dampierian Province. **Meso-scale regions:** Includes Oceanic Shoals, Pilbara (nearshore), Pilbara (offshore), Canning and Eighty Mile Beach regions.
SEB	South Eastern Biotone	**Area:** 53,510 km^2 **Location:** From south of Wollongong to east of Wilsons Promontory at its western edge, and south to Cape Portland, enclosing the Furneaux and the Kent Groups of islands. **Remarks:** Zone of faunal overlap, strongly dominated by warm temperate elements of the Central Eastern Province (CEP). Exhibits smaller influences from the North Eastern (NEP), Tasmanian (TasP), and Bassian Provinces (BassP). Contains a major disjunction near Cape Howe. The extent of southward penetration of northern species appears to be determined by the water masses of the extension of the warm East Australian Current. **Meso-scale regions:** Includes Twofold Shelf, Batemans Shelf, and Flinders regions.
SWB	South Western Biotone	**Area:** 23,120 km^2 **Location:** From Perth in the south to approximately Geraldton in the north. **Remarks:** This very complex marine biotone is characterised by a series of strong disjunctions. An extensive area, over which a range of western warm temperate species emanating from the South Western Province (SWP), Bight Biotone (GABB), and the Gulf Province (GulfP) terminate. Some elements of the Bassian Province (BassP), and widespread species from eastern subtropical and temperate regions (i.e. CEP, SEB and CEB) also reach this far west. It is also the southern limit of a suite of western sub-tropical (CWB) and tropical elements. **Meso-scale regions:** Includes Abrolhos Islands and Central West Coast regions.
SWP	South Western Province	**Area:** 52,040 km^2 **Location:** From Perth to Israelite Bay. **Remarks:** Defined by two primary distribution types: western warm temperate species that emerge from the South Western Biotone (SWB) and extend into the Great Australian Bight Biotone (GABB) and the Gulf Provinces (GulfP); and more widely distributed elements that extend from the South Western Biotone (SWB) eastward into Bass Strait. A smaller suite of eurythermal species extend as far north as the Central Western Biotone (CWB). Major disjunctions exist at its western and eastern boundaries. Some species from the Central Western Province (CWP) extend southward to this region. Western limit of a major provincial region referred to by Whitley (1937) as the Flindersian Province. **Meso-scale regions:** Includes Leeuwin-Naturaliste and WA South Coast regions.

Table 4: Descriptions of IMCRA demersal provinces and biotones for Map 2 continued

Code	Province/ Biotone Name	Description
TasP	Tasmanian Province	**Area:** 32,220 km^2 **Location:** Extending from the north-eastern tip of Tasmania around Cape Naturaliste and encircling the east, south and west coasts up to Cape Grim at its north-western extremity. **Remarks:** Defined by the southern sector of cool temperate Maugean Province (Whitley, 1937). Its core region lies south of Bass Strait. Most species extend westward into the Western Bassian Biotone (WBassB) and Gulf Province (GulfP), and northward to the central part of the South Eastern Biotone (SEB). The province is penetrated in its Eastern sector by elements of the Central Eastern Province (CEP) in summer, but to a lesser extent from the Bassian Province (BassP) or provinces further to the west. **Meso-scale regions:** Includes Franklin, Davey, Bruny and Freycinet regions.
WBassB	West Bassian Biotone	**Area:** 89,751 km^2 **Location:** Extends east from the South Australian Gulf Province (GulfP), penetrating past King Island to a southern limit at the north-western tip of Tasmania and a northern limit slightly north of Apollo Bay in Victoria. **Remarks**: Zone of faunal overlap of elements derived mainly from the Tasmanian (TasP) and Bassian Provinces (BassP) to the east, as well as a small suite of extralimital species from the Central Eastern Province (CEP). Also contains elements from the South Western Province (SWP) and Gulf Provinces (GulfP). **Meso-scale regions:** Otway and Coorong regions.

Table 5: Descriptions of IMCRA pelagic provinces and biotones for Map 3

Code	Province/ Biotone Name	Description
EPB	Eastern Pelagic Biotone	**Area:** 161,000 km^2 **Location:** Extending from Lakes Entrance in the south to Dunk Island in the north. **Remarks:** Represents the major termination zone for western, southern and northern tropical and temperate species. Internal disjunctions within the biotone are numerous, with the major ones occurring just north of Brisbane (Maroochydore), and near Byron Bay, Sydney, Bermagui and Cape Howe.
NPP	Northern Pelagic Province	**Area:** 1,390,000 km^2 **Location:** Extending from just south of North West Cape in the west, encircling the tropical north and down the eastern coast of Australia to Dunk Island which also corresponds to the southern boundary of the Cairns Section of the Great Barrier Reef Marine Park. **Remarks:** Similar western origin to the demersal North Western Province (NWP). The eastern section of the province encloses the Far Northern and Cairns Sections of the Great Barrier Reef Marine Park. Internal disjunctions within the Province are weak and occur near Broome and in the midst of the Eighty Mile Beach (south of Broome) and at Gove.
SPP	Southern Pelagic Province	**Area:** 482,000 km^2 **Location:** Extending from near Albany in the west to Lakes Entrance in the east and enclosing Bass Strait and the Tasmanian waters. **Remarks:** Largely comprised of temperate species. The endpoint disjunctions also represent southern limits for tropical species. Intra-provincial disjunctions occur at Esperance and east of Point Dempster near the western edge of the Baxter Cliffs. In the east, disjunctions occur just east of Kangaroo Island and at Wilsons Promontory.
WPB	Western Pelagic Biotone	**Area:** 119,000 km^2 **Location:** Extending from near Albany in the south to just south of North West Cape. **Remarks:** A strong zone of faunal overlap representing the major termination zone for eastern tropical and temperate species. Internal disjunctions within the biotone are numerous and mimic the structure reflected in the western part of the demersal regionalisation.

Table 6: Nested relationship between meso-scale regions and demersal provinces

Meso-scale Region Name	Meso-scale Region Code	Meso-scale Region Number	Area (km^2)	Demersal Province Name & (Code)
Abrolhos Islands	ABR	32	6,645	South Western Biotone (SWB)
Anson Beagle	ANB	18	20,499	North Western Biotone (NWB)
Arafura	ARA	20	154,999	Northern Province (NP)
Arnhem Wessel	AWS	15	27,438	Northern Province (NP)
Batemans Shelf	BAT	53	6,175	South Eastern Biotone (SEB)
Boags	BGS	45	8,270	Bassian Province (BassP)
Bonaparte Gulf	BON	19	57,597	North Western Biotone (NWB)
Bruny	BRU	47	7,287	Bassian Province (BassP)
Cambridge-Bonaparte	CAB	21	14,962	North Western Biotone (NWB)
Canning	CAN	24	20,014	North Western Province (NWP)
Carpentaria	CAR	12	228,965	Northern Province (NP)
Central Bass Strait	CBS	51	49,310	Bassian Province (BassP)
Central Reef	CRF	5	31,389	North Eastern Province (NEP)
Central Victoria	CVA	50	4,447	Bassian Province (BassP)
Central West Coast	CWC	33	26,185	South Western Biotone (SWB)
Cobourg	COB	58	10,294	Northern Province (NP)
Coorong	COR	43	31,971	Western Bassian Biotone (WBassB)
Davey	DAV	46	6,794	Bassian Province (BassP)
East Cape York	ECY	8	14,535	North Eastern Biotone (NEB)
Eighty Mile Beach	EMB	25	9,724	North Western Province (NWP)
Eucla	EUC	37	111,115	Great Australian Bight Biotone (GABB)
Eyre	EYR	39	72,165	Gulfs Province (GulfP)
Flinders	FLI	49	20,951	South Eastern Biotone (SEB)
Franklin	FRA	57	10,363	Bassian Province (BassP)
Freycinet	FRT	48	8,078	Bassian Province (BassP)
Groote	GRO	14	19,439	Northern Province (NP)
Hawkesbury Shelf	HAW	54	11,424	Central Eastern Province (CAP)
Karumba-Nassau	KAN	11	55,998	Northern Province (NP)
Kimberley	KIM	22	61,035	North Western Biotone (NWB)
King Sound	KSD	23	4,200	North Western Biotone (NWB)
Leeuwin-Naturaliste	LNE	34	26,575	South Western Province (SWP)
Lucinda–Mackay Coast	LMC	4	15,633	North Eastern Province (NEP)
Mackay-Capricorn	MCN	3	54,967	North Eastern Province (NEP)
Manning Shelf	MAN	55	7,681	Central Eastern Province (CAP)
Murat	MUR	38	35,587	Great Australian Bight Biotone (GABB)
Ningaloo	NIN	29	7,339	Central Western Biotone (CWB)
North Spencer Gulf	NSG	40	4,448	Gulfs Province (GulfP)
North West Shelf	NSW	28	153,969	North Western Province (NWP)
Oceanic Shoals	OSS	60	246,404	North Western Biotone (NWB)
Otway	OTW	44	37,331	Western Bassian Biotone (WBassB)
Pellew	PEL	13	25,506	Northern Province (NP)
Pilbara (Nearshore)	PIN	26	13,861	North Western Province (NWP)
Pilbara (Offshore)	PIO	27	41,491	North Western Province (NWP)
Pompey-Swains	PSS	2	56,373	North Eastern Province (NEP)
Ribbons	RBN	7	47,829	North Eastern Biotone (NEB)
Shark Bay	SBY	31	14,071	Central Western Province (CWP)
Shoalwater Coast	SCT	1	20,655	North Eastern Province (NEP)
Spencer Gulf	SGF	41	11,874	Gulfs Province (GulfP)
St Vincent Gulf	SVG	42	12,838	Gulfs Province (GulfP)
Tiwi	TWI	16	5,104	North Western Biotone (NWB)
Torres Strait	TST	9	36,232	North Eastern Biotone (NEB)
Tweed-Moreton	TMN	56	42,712	Central Eastern Biotone (CEB)
Twofold Shelf	TWO	52	32,197	South Eastern Biotone (SEB)
Van Diemens Gulf	VDG	17	17,010	Northern Province (NP)
Victorian Embayments	VES	59	2,880	Bassian Province (BassP)
Victorian Embayments	VES	59	625	South Eastern Biotone (SEB)
WA South Coast	WSC	36	47,310	South Western Province (SWP)
Wellesley	WLY	35	27,274	Northern Province (NP)
West Cape York	WCY	10	21,663	Northern Province (NP)
Wet Tropic Coast	WTC	6	6,000	North Eastern Province (NEP)
Zuytdorp	ZUY	30	38,954	Central Western Province (CWP)
Total	=		2,224,661 km^2	

Table 7: Proposed IMCRA provinces for the External Territories to be included in IMCRA 4.0
(see Map 4) *

Code	Province/ Biotone Name	Description
AAP	Australian Antarctic Province	**Location:** Eastern Antarctica. **Remarks:** Defined by the East Antarctic District of the South Polar Province (Gon and Heemstra, 1990). The cold water biota is typically widely distributed around the polar circle but has some elements confined to the eastern sector. These extend from the Ross to the Weddell Seas into the dependencies of Britain, Norway, France and New Zealand. **Meso-scale regions:** No regions defined to date.
SunP	Sunda Province	SunP (a) Christmas Island SunP (b) Cocos (Keeling) Islands **Location:** Comprising Cocos and Christmas Islands. **Remarks:** Tropical islands and atolls close to the Javanese coast. Typically with coral and tropical reef biotas of the Indo–West Pacific. Shares considerable overlap with the North Western Province (NWP) but has some endemic elements. **Meso-scale regions:** No regions defined to date.
KergP	Kerguelen Province	**Location:** Comprising Heard and McDonald Islands and associated seamounts. **Remarks:** A broad region of the Indian Ocean including deep submarine ridges and sub-Antarctic islands (Kerguelen, Crozet, Heard and McDonald) known as the Kerguelen Province (Gon and Heemstra, 1990). The region contains widely distributed Antarctic species and a few endemics but lacks cool temperate elements. **Meso-scale regions:** No regions defined to date.
MacP	Macquarie Province	**Location:** Comprising Macquarie Island and associated seamounts. **Remarks:** Formerly part of Whitley's (1937) broad Rossian Province, we now know that the biota is distinct. The inshore biota resembles that of Antarctica but along the deep submarine ridges the biota is a mixture of Antarctic and cool temperate elements normally found well north. The temperate biota, is dominated by New Zealand species and more widely occurring species also found off southern Australia. **Meso-scale regions:** No regions defined to date.
NorfP	Norfolk Province	NorfP (a) Norfolk Island NorfP (b) Lord Howe Island NorfP (c) Elizabeth and Middleton Reefs **Location:** Comprising Norfolk and Lord Howe Islands, Middleton and Elizabeth Reefs, and associated seamounts. **Remarks:** A well-defined subtropical province with a strong mix of both tropical Indo-Pacific species and warm temperate species from Australia and New Zealand. It also has a significant endemic component. Of the neighbouring temperate regions, the inshore fauna most closely resembles that of Australia's Central Eastern Province. Offshore, on the submarine ridges, it shares closer affinities with New Caledonia and New Zealand. Defined by Whitley (1937) as the Phillipian Province. **Meso-scale regions:** No regions defined to date.

** see **Appendix 6** for the biophysical descriptions of the proposed IMCRA provinces for the External Territories*

Appendix 1
Specifications for developing the IMCRA regionalisation

The primary purpose for developing IMCRA was to provide an ecologically based, regional planning framework for establishing the NRSMPA (Muldoon 1995).

In March 1995 the Biodiversity Group of Environment Australia (formerly the Australian Nature Conservation Agency) prepared and circulated a discussion paper which outlined the specifications for developing IMCRA based on the Interim Biogeographic Regionalisation for Australia (IBRA) model.

Ecological considerations

- The required spatial data for planning the NRSMPA was at the meso-scale and that this level of information needed to be presented within a biogeographic regionalisation where the State, Territory and Commonwealth borders would not be visible.
- The March 1995 technical meeting agreed on a list of the hierarchical biogeographic terms to be used by each of the marine management agencies. The main product to be developed was a regional or meso-scale regionalisation and the primary mapping unit is the region. Data and information for the inshore waters of IMCRA was to be based on existing State and Territory biogeographic classification systems that show consistency in approach at this level.
- IMCRA is to be based on a conceptual model that summarises the primary biophysical processes that are considered to be responsible for driving the patterns of biological diversity and productivity in the coastal and marine environments.
- Where practical, IMCRA is to be developed using similar or compatible biophysical datasets within and across jurisdictions, that is, attributes, resolution, accuracy, reliability and scale.
- IMCRA is to be a spatial planning framework that is flexible, dynamic and pragmatic. It is to reflect an integration of data and information by ecologists across planning and management jurisdictions.
- Where possible, IMCRA should be integrated with IBRA, which has been endorsed by all nature conservation agencies for developing the terrestrial national reserve system on the land (Thackway & Cresswell 1995).
- IMCRA needs to clearly specify the various methods used in development of the biogeographic regionalisation, that is, the various biophysical datasets and methods used to classify these datasets.
- Attributes to be incorporated in the classification of meso-scale regions include climate, substrate, bathymetry, water chemistry, sediment, and flora and fauna.

Administrative and collaborative guidelines

- The Commonwealth is to provide assistance to facilitate the development of IMCRA.
- IMCRA is to be developed as a collaborative venture with the relevant marine management and research agencies.
- Marine management agencies (that is, nature conservation and fisheries) are to be responsible for the maintenance and custodianship of the regionalisation/s for their own jurisdiction as well as for the coordination of inputs/analyses/outputs used to develop the regionalisation/s.
- IMCRA should be developed from reliable and up-to-date information and involve available specialist knowledge.
- Any future changes to IMCRA region boundaries are to be discussed and reviewed by the specialists within the relevant marine management agencies to ensure consistency of descriptions, attributes and boundaries, both within the jurisdiction and nationally.
- IMCRA is to be updated regularly, once it is agreed to, with each managing agency being responsible for their own jurisdiction. Provision will need to be made by the participating agencies for at least annual updates.
- IMCRA should be endorsed by ANZECC.

Issues of presentation and access to information about IMCRA

- IMCRA regionalisation products must be accessible to a wide range of stakeholders and interest groups.
- IMCRA is to be presented in an easy-to-understand technical report with an accompanying colour map presented on an inset A3 size sheet of paper. Other products, such as brochures, poster maps and Internet home pages, should also be used where appropriate.
- IMCRA is to be maintained as a GIS dataset. Copies of IMCRA will be made available to each participating agency.
- Provided resources permit, IMCRA products will be provided free of charge.

Acknowledgments, caveats, limitations and assumptions

- IMCRA must state that it was established for the MPA Program, as the regional planning framework for developing the NRSMPA.
- IMCRA regionalisation products must specify the assumptions that underlie the regionalisation, and provide details of its limitations.

Key References:

Muldoon, J. (ed), 1995. Towards a marine regionalisation for Australia. Proceedings of a workshop held in Sydney, New South Wales, 4–6 March 1994. Ocean Rescue 2000 workshop series, Publication No. 1, Great Barrier Reef Marine Park Authority.

Thackway, R. & Cresswell, I. D. (eds), 1995. An Interim Biogeographic Regionalisation for Australia: a framework for establishing the national system of reserves, Version 4.0. Australian Nature Conservation Agency, Canberra.

Appendix 2

Description of the approaches used by the inshore waters working group (States and the Northern Territory agencies) to derive the meso-scale IMCRA regionalisation

Jurisdiction Custodian/s	Description of regionalisation processes and products

VICTORIA
Department of Natural Resources and Environment (DNRE), Parks, Flora and Fauna Division

Primary data sources:
- Biological and physical data
- Coastal geomorphology
- Tidal attributes
- Oceanography
- Intertidal invertebrates

Method used to derive the regionalisation:
Combination of numerical classification and expert knowledge.

Map scale of the regionalisation used as input to the IMCRA:
1:500,000

Number of regions pre-IMCRA: Six
Number of regions post-IMCRA: Six

Digital coastline dataset used to define the inshore IMCRA region boundaries:
AUSLIG Hydrographic: 1:500,000 dataset

Sources of Digital data map:
AUSLIG

Procedure used to delineate region boundaries and describe IMCRA attributes:

1. DNRE used ARC/INFO and the 1:500,000 coastline to generate a 5.5 km buffer around the coastline to distinguish State from Commonwealth waters.
2. DNRE manually transfer the regions boundaries from 'Environmental Inventory of Victorian Marine Ecosystems (stage 1)' Victorian Institute of Marine Sciences et. al.(1994).
3. DNRE sent the digital spatial data with attributes attached to ANCA.
4. ANCA added the Victorian ARC/INFO coverage into the national dataset.
5. ANCA checked the output against hard copy plots supplied by the custodian and, in consultation with the custodian, adjusted the boundaries as necessary.

Extent of stakeholder inputs/involvement within jurisdiction:
Subject to peer review during development. Formal targeted review undertaken following completion of the initial version; review comments addressed through follow up work. Final version included in documents released for public comment by the Land Conservation Council, as part of the Marine and Coastal Special Investigation.

Key References:

Hamilton, N. T. M., 1994. *Environmental Inventory of Victoria's Marine Ecosystems–Stage 2: A physical classification of Bass Strait Waters–Pattern analysis of selected attributes together with a review of an existing shore-based classification.* An unpublished report to the Land Conservation Council and the Department of Conservation and Natural Resources.

Victorian Institute of Marine Sciences, Consulting Environmental Engineers, Dames and Moore and Museum of Victoria, 1994. *Environmental Inventory of Victoria's Marine Ecosystems–Stage 1: Biophysical classification.* An unpublished report to the Land Conservation Council and the Department of Conservation and Natural Resources.

Jurisdiction Custodian/s	Description of regionalisation processes and products

TASMANIA

Department of Environment and Land Management,

National Parks and Wildfire Service &

Department of Primary Industry and Fisheries

Primary data sources:

- Reef fish, invertebrate and plant census data
- Soft-sediment fish data
- Beach-washed mollusc data
- February and July NOAA satellite water temperature data (CSIRO)

Method used to derive the regionalisation:
Multidimensional scaling (MDS). Ecotone analysis and overlap of species ranges.

Map scale of the regionalisation used as input to the IMCRA:
1:500,000

Number of regions pre-IMCRA: Three
Number of regions post-IMCRA: Eight

Digital coastline dataset used to define the inshore IMCRA region boundaries:
Tasmania Coastline (1980's) 1:500,000

Sources of Digital data map:
Genasys GIS (Parks and Wildlife Service)
Tasmap (Deptartment Environment and Land Management, DELM)

Procedure used to delineate region boundaries and describe IMCRA attributes:

1. Bioregions derived from multidimensional scaling (MDS) and further analysis were manually transferred to Tasmania coastline. (The buffer command was used to define the boundary between State and Commonwealth Waters).
2. DELM sent the digital spatial data with attributes attached to ANCA.
3. ANCA added the dataset to the national coverage after converting Genamap digital files to ARC/INFO format.
4. ANCA checked the output against hard copy plots supplied by the custodian.

Extent of stakeholder inputs/involvement within jurisdiction:
Parks and Wildlife Service (principal involvement)
Department of Primary Industry and Fisheries (secondary involvement)

Key References:

Edgar, G.J., Moverley, J., Barrett, N.S., Peters, D. and Reed, C., 1996. The conservation-related benefits of a systematic marine biological sampling program: the Tasmanian reef bioregionalisation as a case study. *Biological Conservation,* in press.

Edgar, G.J., Moverley, J., Peters, D. and Reed, C., 1995. *Regional classification of Tasmanian coastal waters and preliminary identification of representative marine protected area sites.* Unpublished report to ANCA, Marine Protected Area Program D705. (ANCA Library Reference number 574.91946)

Jurisdiction Custodian/s	Description of regionalisation processes and products

NEW SOUTH WALES

NSW Fisheries & NSW National Parks and Wildlife Service

Primary data sources:
- Biological and physical data

Method used to derive the regionalisation:
NSW bioregions were identified and delimited by synthesising and mapping information from published literature, numerically analysing relevant physical and biological datasets, and using expert knowledge to confirm the validity of the numerical results.

Map scale of the regionalisation used as input to the IMCRA:
1:100,000

Number of regions pre-IMCRA: Five
Number of regions post-IMCRA: Five

Digital coastline dataset used to define the inshore IMCRA region boundaries:
AUSLIG (1993) Coastline 1:100,000 dataset

Latitude/Longitude of extremities determined manually at 1:25,000

Sources of Digital data map:
AUSLIG

Procedure used to delineate region boundaries and describe IMCRA attributes:

1. ANCA obtained a detailed manual description of the regions from NSW Fisheries.
2. ANCA used ARC/INFO and the 1:100,000 coastline to generate a 5.1 km buffer around the coastline to distinguish State from Commonwealth waters.
3. ANCA defined the start and end boundaries of each IMCRA region along the coastline by using latitude and longitude coordinates supplied by NSW Fisheries. These lines began at the coastline and ended at the 5.1 km buffer, perpendicular to the coast.
4. Polygons for each region were then built and the attributes added.
5. ANCA added the dataset to the national ARC/INFO dataset.
6. ANCA checked the output against hard copy plots supplied by the custodian.

Extent of stakeholder inputs/involvement within jurisdiction:
Representatives of the marine community in NSW agreed on the need for a IMCRA database, and which components should be used to derive this database (Workshop 1994).

Key References:

Ortiz, E., 1992. *The development of a representative system of marine and estuarine protected areas for New South Wales.* Unpublished Report by the NSW Fisheries for the Australian National Parks and Wildlife Service, August 1992. pp. 37.

Ortiz, E. and Pollard, D. 1995. *The development of a representative system of marine and estuarine protected areas for New South Wales.* In, *Towards a Marine Regionalisation for Australia,* edited by J. Muldoon, Ocean Rescue 2000 Workshop Series, Publication Number 1. Great Barrier Reef Marine Park Authority.

Jurisdiction Custodian/s	Description of regionalisation processes and products

SOUTH AUSTRALIA

South Australian Research & Development Institute (SARDI)

Primary data sources:

- Biological and physical data
- Oceanography
- Coastal geomorphology
- Subtidal habitats
- Intertidal habitats
- Mangroves

Method used to derive the regionalisation:
Intuitive or 'delphic approach' to classification. Original classification based on the outcome of the 'South Australian Marine Protected Areas Workshop', held in November 1991 (Edyvane & Baker 1995). Regions manually transferred to a MapInfo map of the SA coast.

Map scale of the regionalisation used as input to the IMCRA:
1:2,500,000

Number of regions pre-IMCRA: Four
Number of regions post-IMCRA: Eight

Digital coastline dataset used to define the inshore IMCRA region boundaries:
Division of National Mapping, Department of Minerals & Energy (1978):
Coastline 1:2,500,000 dataset

Sources of Digital data map:
Division of National Mapping, Department of Minerals & Energy, Canberra ACT.
Printed by Royal Australian Surveys Corps 1978

Procedures used to delineate boundaries and describe IMCRA attributes:

1. Bioregions derived from IMCRA March 1995 workshop were manually transferred to original MapInfo map. (The 200 m bathometric contour was used to define the boundary between inshore and offshore waters.)
2. SARDI sent the digital spatial data with attributes attached to ANCA.
3. ANCA added the South Australian dataset to the national coverage after converting MapInfo digital files to ARC/INFO format.
4. ANCA checked the output against hard copy plots supplied by the custodian.

Extent of stakeholder inputs/involvement within jurisdiction:
Original pre-IMCRA classification developed and endorsed in November 1991, by key SA technical marine specialists at the 'South Australian Marine Protected Areas Workshop'.

Key References:

Edyvane, K. and Baker, J. 1995. The South Australian marine regionalisation project. In, *Towards a Marine Regionalisation for Australia*, edited by J. Muldoon, Ocean Rescue 2000 Workshop Series, Publication Number 1. Great Barrier Reef Marine Park Authority.

Jurisdiction Custodian/s	Description of regionalisation processes and products

WESTERN AUSTRALIA

Conservation and Land Management (CALM)

Primary data sources:
- Physical and biological data.

Method used to derive the regionalisation:
Based on a geomorphic classification, derived by an expert panel.

Map scale of the regionalisation used as input to the IMCRA:
Variable depending on the size of the area (see Wilson report: CALM 1994).

Number of regions pre-IMCRA: Twenty-five
Number of regions post-IMCRA: Eighteen

Digital coastline dataset used to define the inshore IMCRA region boundaries:
AUSLIG (1993) coastline 1:100,000 dataset.

Sources of Digital data map:
AUSLIG 1:100,000 (1993) coastline plus digital capture by CALM (WA)

Procedure used to delineate region boundaries and describe IMCRA attributes:

1. The Marine Parks and Reserves Selection Working Group (CALM 1994) generated maps covering various parts of the WA coastline. Microstation software was used to capture these descriptions. The number of marine types derived by this working group was greater than 25.
2. In preparation for the IMCRA workshop held in Sydney, Hugh Chevis and Barry Wilson consolidated the number of marine types to derive 25 regions for the WA coastline.
3. At the workshop held in March 1995 in Sydney, the number of bioregions was consolidated to give 16 regions for WA.
4. ANCA sent to CALM a list of the WA IMCRA regions defined at the March 1995 Workshop for checking.
5. CALM extracted the latitude and longitude points for WA IMCRA boundaries manually referring from a 100,000 map sheet.
6. ANCA obtained a detailed manual description of the regions from CALM.
7. ANCA defined the region start and end boundaries along the coastline by using lat/long coordinates supplied by CALM. These lines began at the coastline and ended at the 5.1 km buffer, perpendicular to the coast.
8. Polygons for each region and then built and the attribute added.
9. ANCA added the Western Australian dataset to the national coverage.
10. ANCA checked the output against hard copy plots supplied by the custodian.

Extent of stakeholder inputs/involvement within jurisdiction:
Once the Wilson report was produced, public meetings were convened, and one-to-one meetings were held. In addition, a period of public comment was provided and CALM received more than 200 submissions on the report.

Key References:

CALM, 1994. A Representative Marine Reserve System for Western Australia. Report of the Marine Parks and Reserves Selection Working Group. Department of Conservation and Land Management (WA).

Chevis, H., 1995. The Western Australian marine regionalisation project. In, *Towards a Marine Regionalisation for Australia,* edited by J. Muldoon, Ocean Rescue 2000 Workshop Series, Publication Number 1. Great Barrier Reef Marine Park Authority.

Jurisdiction Custodian/s	Description of regionalisation processes and products

NORTHERN TERRITORY

Parks and Wildlife Commission (PWC NT)

Primary Data Sets:

- Biological data–fish assemblages, mangrove distributions, barramundi genetic stock distributions
- Physical data–rainfall, stream discharge, cyclone frequency, sea surface temperature, hydrology, tidal amplitudes, sea floor sediments, structural geology, coastal geomorphology.

Method used to derive the regionalisation:
Patterns in spatial digital coverages of attributes were elicited using iterative overlay techniques to produce IMBRENT.

Map scale of the regionalisation used as input to the IMCRA:
1:500,000 nominal

Number of regions pre-IMCRA: Two
Number of regions post-IMCRA: Thirteen

Digital coastline dataset used to define the inshore IMCRA region boundaries:
AUSLIG (1980's) coastline 1:1,000,000 dataset

Sources of Digital data map:
AUSLIG

Procedure used to delineate regional boundaries and describe IMCRA attributes:

1. IMBRENT regions delineated iteratively from spatial coverages. Limit of inshore regions defined by 30 m isobath. Isobath digitised in ARC/INFO from Naval Hydrographic Service Charts Aus 316, Aus 309, Aus 721, Aus 442, Aus 306 and Aus 305, Inshore boundary AUSLIG 1:1,000,000 coastline.
2. IMBRENT regional coverage and attribute files sent to ANCA.
3. IMBRENT regions combined with State contributions.
4. ANCA checked the output against hard copy plots supplied by the custodian.

Note: The 1,000,000 coastline used by NT was removed and replaced with 100,000 coastline (AUSLIG 1993).

Extent of stakeholder inputs/involvement within jurisdiction:
Workshop involving stakeholders was held in April 1995.
General acceptance of IMBRENT regions achieved.

Key References:

Ferns, L. and Billyard, R.W., 1995. *Interim Biophysical Regionalisation of the Northern Territory (IMBRENT): Rationale, Derivation and Biophysical Regional Attributes.* Conservation Commission of the NT, Darwin.

Ferns, L. and Billyard, R.W. (in prep). Geographic Information Systems (GIS) as a tool in the construction of a marine meso-scale biophysical regionalisation for the Northern Territory, Australia.

Jurisdiction Custodian/s	Description of regionalisation processes and products

QUEENSLAND

Department of Environment

Primary data sources:

- Published literature on distribution of physical and biological features.

Method used to derive the regionalisation:
Numerical overlay of multiple mapped distributions, with reference to more specific studies.

Map scale of the regionalisation used as input to the IMCRA:
Variable according to datasets, nominal 1:250,000.

Number of regions pre-IMCRA: Twelve
Number of regions post-IMCRA: Fourteen

Digital coastline dataset used to define the inshore IMCRA region boundaries:
AUSLIG (1993) Coastline 1:100,000 dataset.

Sources of Digital data map:
Various–parts of AUSLIG 1:100 000 coast, RAN bathymetry, GBRMPA boundaries, QLD Marine Park Boundaries, mostly digitised data from maps in literature and Department of Environment.

Procedure used to delineate region boundaries and describe IMCRA attributes:

1. Locate suitable datasets, and where necessary interpret and digitise.
2. Overlay each digital dataset on 30' grid, score each cell for value from dataset; and produce large cells by attributes matrix.
3. Numerical analyses of matrix, testing for robustness and coincident boundaries between physical, biological and oceanographic suites of datasets.
4. Plot similar cells at a level of interpretation that gives a meso-scale classification, and smooth boundaries.
5. Reality check through site specific studies.
6. Map info coverage sent to ANCA and amalgamated with national coverage.
7. ANCA checked the output against hard copy plots supplied by the custodian.

Note: The project team made the decision not to limit the study area to the State/Commonwealth water boundary, thus the outer boundary defines the end of the continental shelf (200 m bathymetric contour).

Extent of stakeholder inputs/involvement within jurisdiction:
Quite wide but informal, e.g. CSIRO Cleveland, Queensland Department of Primary Industry, James Cook University, University of Queensland, and the Great Barrier Reef Park Authority. No formal consultative or delphic process attempted.

Key References:

Stevens, T. (1995). Queensland marine habitats–a biophysical classification at the meso-scale for conservation planning. In: Muldoon J. (ed.) (1995), Towards a marine regionalisation for Australia. Proceedings of a workshop held in Sydney, NSW 4–6 March 1994. Ocean Rescue 2000 workshop series, Publication No. 1, Canberra.

Page and Stevens (1995). Ocean Rescue 2000–QDEH* Progress Report and Financial Statement for 1994–95.

**Queensland Department of Environment and Heritage.*

Appendix 3

Description of the approaches used by the offshore waters working group (Commonwealth agencies) to derive the provincial scale regionalisations

Fish Regionalisations

CSIRO Marine Research used fish species composition and richness as the basis for deriving provincial scale bioregions. This strategy was used for two reasons:

1. High levels of marine fish biodiversity are often associated with areas having compressed hydrologic and climatic environment gradients, particularly when associated with high habitat diversity, as these conditions enable organisms with widely diverging requirements to coexist (McAllister, 1994; Gilmore, 1995). Under these conditions it is likely that biodiversity 'hotspots' will coincide across taxa, since features which produce fish species-richness affect other marine fauna and flora in a similar manner.
2. Fish data provide the only practical means of obtaining a bioregionalisation of marine Australia since there are no other taxa for which detailed EEZ-wide occurrence data are available.

This project used a comprehensive dataset of fish distribution for estuarine/coastal and shelf systems out to a depth of 200 m The data were refined and vetted by Australian taxonomic specialists using their own databases and knowledge.

Given the generally accepted lack of ecological linkages between pelagic and demersal systems, separate bioregionalisations were derived for each system. The coarse level of detail available for these systems meant that it was only possible to develop provincial scale regionalisations. However, there are some areas within the EEZ where more detailed data, equivalent to the meso-scale of the coastal waters, are available.

A feature of these regionalisations is the recognition and demarcation of biotones and their contributory core provincial bioregions. Core provincial bioregions were identified by the presence of provincial groups of narrow-range species sharing little overlap with other provinces. In contrast, biotones are bioregions where widerange species from one or more provincial bioregions mix. Thus, whilst the distribution of species represented in core provincial bioregions may extend well into the neighbouring biotones, it does so in conjunction with species from other provinces.

The pelagic bioregionalisation comprises four bioregions (two provinces and two biotones) of much more extensive spatial scale than the demersal bioregionalisation (17 bioregions, 9 provinces and 8 biotones).

Subprovincial disjunctions were observed in the demersal biotones. The relative strengths of the biotones and core provincial bioregions do vary and a future task is to identify the relative strengths based on the species distribution information.

Key References:

Gilmore, R.G. 1995. Environmental and biogeographic factors influencing ichthyofaunal diversity: Indian River lagoon. *Bulletin of Marine Science,* 57 (1):153–170.

McAllister, D.E., Schueler, F.W., Roberts, C.M. and Hawkins, J.P. 1994. Mapping and GIS analysis of the global distribution of coral reef fishes on an equal area grid. pp155–175, In *Mapping the Diversity of Nature,* R. I. Miller (ed), Chapman and Hall, London.

Physical Oceanographic Water Column Regionalisations

This project used physical oceanographic attributes as the basis for deriving provincial scale regions. This strategy is based on the observation that physical attributes, when classified into environmental groups, are correlated with distribution patterns of flora and fauna. These physical attributes are believed to provide meaningful surrogates of these species' habitats. Further work is needed to test the validity of the surrogates used in regionalisations.

CSIRO derived a series of physical oceanographic regionalisations for three depth layers using a range of oceanographic attributes including: salinity, temperature, nitrate and silicate. Data were collated from the high water mark to the edge of the EEZ and the sea floor.

A 0–50 m surface layer was chosen to show surface attributes which would be more active in coastal areas. A thermocline layer (150 m), showing the intensity of penetration for the seasonal mixing signal, was chosen to show features that are likely to affect pelagic species. A deep water layer (800–1000 m) was chosen to show deep water salinity, thought to influence distributions of deep-sea fauna. These regionalisations also examined seasonal patterns (i.e. summer, autumn, winter and spring periods) in these depth classes.

Benthic Habitat Regionalisations

This work was undertaken by AGSO, CSIRO Division of Wildlife and Ecology and the Ocean Science Institute of Sydney University. Sea floor topography and sediment type were used as surrogates in the delineation of benthic biological habitats.

The topographical analysis has been simplified for the purposes of this report into 8 classes delineating the distribution of major shelf, slope and abyssal habitats of the Australian EEZ.

Simplified results of the analysis of sediment distributions are to be found on the world-wide web at:

<http://www.es.su.oz.au/osi/au7_imgs.html>

The oceanographic characteristics at the sea bed were analysed to provide additional data for the benthic habitat regionalisation.

This work is of sufficient resolution to provide the basis for more detailed meso-scale and provincial-level regionalisations of benthic habitats than was necessary for the IMCRA stage of regionalisation.

Work Towards a Single Provincial Level Regionalisation

Work has commenced on the development of a single provincial level regionalisation using existing information on biological and physical attributes to extend across the entire EEZ. The revised provincial level regionalisation will be circulated to the developers of the IMCRA for review and comment. It is expected that a revised provincial level product will be available for inclusion in the next major revision of the IMCRA report.

Key References:

CSIRO (1996) *Interim Marine Bioregionalisation for Australia: Towards a National System of Marine Protected Areas.* CSIRO Division of Fisheries and Division of Oceanography. Draft report to Environment Australia (ERIN).

Appendix 4

Guidelines for integrating the IMCRA regionalisations developed by the inshore and offshore working groups

Guidelines* for integrating the inshore and offshore regionalisations

- Use existing information and the consensus of specialists from a wide range of marine disciplines, in particular, marine resource management agencies.
- Incorporate an hierarchical data structure whereby the largest or first-order regions coincide with those developed for the oceanic provinces, where finer subdivisions are homogeneous areas called 'regions' and 'units' respectively (see Thackway & Cresswell 1995c).
- Develop a set of guidelines for defining the desired scale, for drawing 'firm' and 'fuzzy' boundaries, and for splitting and lumping regions within IMCRA.
- Ensure that each region is relatively homogeneous, based on physical oceanography and biological attributes.
- Define the level of attributes required to describe each region.
- Give approximate equal weight to each of the attributes in the framework.
- Develop an agreed nomenclature for each of the regions in IMCRA, that is, common names and a look-up table to relate IMCRA names to existing State and Territory and Commonwealth region names and mapping codes.
- Where possible ensure that the total number of regions in the spatial framework does not exceed 100 regions.
- Ensure that the boundary between the inshore and offshore waters is not based upon jurisdictional boundaries, for example, 3 or 12 n miles.
- In developing the IMCRA exclude the following Australian External Territories – Heard and MacDonald Islands, Christmas Island, Cocos and North Keeling Islands, and Antarctica.
- Following the integration establish a process of review and revision of the region boundaries by peer review of specialist scientists (for example, managing agencies, tertiary and research institutions).

** The above guidelines were prepared by the Biodiversity Group (Environment Australia), in consultation with ERIN, and were endorsed by the ANZECC Task Force on Marine Protected Areas in February 1996.*

Appendix 5
Detailed IMCRA meso-scale regional descriptions

Region Code	Data Attribute	Description
ABR	WA/32	Abrolhos Islands
	Climate:	Temperate with a moderate winter rainfall.
	Oceanography:	The water is clear and oceanic. Of paramount importance is the warm south-flowing Leeuwin Current in late summer and winter which is believed to introduce propagules of tropical animals from more northerly locations. Tidal range is diurnal with a maximum range of 1 m. Wave energy is high on the seaward reefs, moderate on the leeward sides and low in the lagoons.
	Geology & geomorphology:	The four carbonate platforms are composed of Pleistocene coralline limestone with Holocene sand sheets and prolific contemporary coral growth in back-reef and lagoonal situations. Coral growth has been intermittent through the Quaternary. The reef platforms are separated by 40 m deep channels. Located close to the shelf edge, there is a steep outward slope off their seaward sides. The leeward, eastern sides shelve onto the wide mid-shelf platform between the islands and the mainland. Each of the reef platforms has a complex of reef-front, lagoonal, back-reef and channel habitats. There are many emergent rock platforms forming low limestone islands and, in the Wallabi Group, three larger islands with eolianite and Holocene dune mantles, rising to heights up to 50 m. The seabed surrounding the reef platforms bears deposits of carbonate sands.
	Biota:	The Abrolhos coral reefs are the most southerly in the Indian Ocean. They have a remarkably high species diversity with 184 species recorded, belonging to 42 genera. The associated fish and invertebrate fauna, however, is a blend of temperate, tropical and West Coast endemic species, making these reef communities unique in Australia and of great scientific interest. In the contemporary phase of reef growth, corals are dominant in the lagoonal and back-reef areas while the high-energy seaward side of the reefs are dominated by macro-algae. In this respect also the Abrolhos reefs are unusual. One species of mangrove (*Avicennia marina*) is present in some sheltered areas but forms only very small mangals. There are well developed seagrass meadows on the northern side of West Wallabi Island. Many of the islands are important nesting sites for seabirds and, for this reason alone, have high conservation value. The eastern Indian Ocean subspecies of the lesser noddy tern (*Anous tenuirostris melanops*) nests only at the Abrolhos. The high islands of the Wallabi Group support relict populations of terrestrial flora and fauna, including the tammar wallaby and a threatened eucalypt (*Eucalyptus oraria*).
	Estuaries:	Nil

Region Code	Data Attribute	Description
ANB	NT/18	Anson-Beagle
	Climate:	Climate is monsoon tropical. Rainfall varies from 1200 mm in the south of the subregion to over 1700 mm in the north, with the majority falling in the monsoon (wet) season between November and March. Runoff varies between 250–1000 mm of annual rainfall. Riverine discharge is relatively low with the exception of the Daly, Finniss and Adelaide Rivers. Cyclone frequency is low to moderate. Prevailing winds are seasonal with north-west monsoons in November to March giving way to south-east trade winds from May to September.
	Oceanography:	The breadth of the continental shelf means that oceanic currents exert only minor influence on the region. In the dry season (May–September), a general south-westerly drift is associated with south-easterly winds, the Indonesian Throughflow and the South Equatorial Current. Wet season (November to March) circulation is dominated by north-easterly drift generated by north-westerly monsoonal winds. The Beagle Gulf is dominated by strong internal circulation, with little oceanic interaction. Tidal range is approximately 6–8 m. Annual variation in sea surface temperature is 5–6°C. Monsoonal conditions generate turbulent wave action and high turbidity along this coast during the November to March wet season.
	Geology & geomorphology:	Underlying lithology is dominated by Permian siltstones and sandstones of the Bonaparte Gulf Basin in the west, and in the east Proterozoic siltstones and sandstones of the Pine Creek Geosyncline. Areas in the north-east are overlain by Cretaceous sandstones and siltstones of the Bathurst Island Formation. Major geomorphological features are the ria shorelines in Darwin and Bynoe Harbours, the Vernon Island reef complex on the eastern boundary and sandy beaches backed by chenier ridge systems and low (<10 m) cliffed headlands on the western coast. Numerous rocky reefs and shoals are scattered throughout the region. Coralline fringing reefs and patch reefs are sparsely distributed, generally occurring in association with coastal rocky outcrops. The Peron Islands, two extensive sand cays overlying Permian sandstones and siltstones, are located one kilometre offshore in the south-west of the region. In common with the rest of the Territory coast, the continental shelf is broad and shallow. The region is approximately 25 km in width from the high water mark to the seaward boundary of the region on the 30 m depth contour. Seafloor sediments are dominated by coarse sands and gravels in the east of the region, principally of terrigenous origin in Darwin and Bynoe Harbours grading to biogenic in the north-east. In the west of the region benthic sediments are dominated offshore by biogenic sands and muds, with terrigenous sands and muds inshore, particularly close to the mouths of the Finniss and Daly Rivers.
	Biota:	Extensive fringing mangrove communities are widespread in the region, including 19 000 ha of mangrove forests within Darwin Harbour. Mangrove diversity is high, with 38 of the 48 possible species occurring in the region. The region supports extensive wading bird habitat, particularly in Shoal Bay and the Grose Islands, the Territory's largest pelican rookery (on the Peron Islands), and extensive wading bird habitat in Fog Bay, Anson Bay and the Little Moyle River. Juvenile green and hawksbill turtle feeding habitat is located at the Grose Islands, as is flatback turtle nesting habitat. Feeding habitat for olive Ridley and loggerhead turtles occurs on shellfish beds in Fog Bay. Locally high dugong numbers occur on seagrass beds in Bynoe Harbour, Shoal Bay and at the Peron Islands. Reef benthos in the turbid waters of Darwin and Bynoe Harbours is dominated by sponges and soft corals and corals of the genus *Turbinaria*, while in clearer waters at the Vernon Islands hard corals such as *Acropora* and *Montipora* predominate. Extensive coralline algal terraces are developed at the Grose Islands and the Vernon Island reef complex.
	Estuaries:	Due to high wet season flows and macrotidal regimes, estuarine types are dominated by straight-banked river mouths (9 of 19 major estuaries). Two extensive headland enclosed estuaries (Bynoe and Darwin Harbours) occur on ria shorelines close to Darwin. Major estuaries: Darwin and Bynoe Harbours and the Finniss, Daly, and Adelaide Rivers.

Region Code	Data Attribute	Description
ARA	NT/20	Arafura
	Climate:	Mean annual rainfall is approximately 1300 mm. Cyclones occur with low to moderate frequency.
	Oceanography:	Oceanic circulation is seasonal, being dominated by westerly flows during the dry season (April to October) and easterly flows during the wet season (November to March). Sea surface temperatures vary 5–6°C annually.
	Geology & geomorphology:	The Arafura Basin forms the major tectonic unit. Sediments are muds and sandy muds of biogenic origin.
	Biota:	Little data is available on wildlife occurrences. Fish assemblages are similar to those in deeper waters (>30 m depth) of the Gulf of Carpentaria and distinct from those of the Bonaparte Region to the west.
	Estuaries:	Nil
AWS	NT/15	Arnhem-Wessel
	Climate:	Climate is monsoon tropical. Rainfall ranges from 1200 mm to more than 1400 mm annually. Cyclone frequency is low to moderate. Runoff ranges from 200–500 mm of annual rainfall. Riverine discharges are moderate via the Mann, Blyth and Goyder Rivers.
	Oceanography:	Currents are generally easterly in the wet season (October–March) and westerly in the dry season (May–September). The coastline is relatively exposed to wave action during the wet season (November–March). Sea surface temperatures vary by 4–7°C annually. Tidal range is meso-tidal (3–5 m variation) building to 5–6 m in Castlereagh, Buckingham and Arnhem Bays.
	Geology & geomorphology:	Geology is dominated by Cambrian and Ordovician sandstones, siltstones and shales of the Arafura Basin and sandstones of the Carpentarian Walker Fault Zone. Geomorphology is diverse, ranging from the rocky sandstone islands of the Wessel and English Company Groups, deeply incised mangrove and beach lined bays in the eastern coastline, to sandy beaches with low rocky headlands and mangrove fringed saline mudflats along the western coastline. Fine grained sediments, mainly muds and sandy muds, terrigenous inshore grading to biogenic offshore.
	Biota:	Mangrove diversity is moderate (22 species) in the west and high (39 species) in Arnhem Bay in the east. Mangroves community types are largely fringing and riverine communities, however extensive communities exist in Castlereagh and Arnhem bays. Wading bird habitat exists in association with mangrove wetlands ion the eastern part of the region. Locally high dugong numbers exist close to Elcho island and the King River in the west of the region. Turtle populations are high with nesting occurring on most beaches in the region. Seabird rookeries are common on islands throughout the region.
	Estuaries	Estuarine types dominated by straight-banked river mouths (13 of 27 major estuaries) and spit-lagoon estuaries (9 of 27 major estuaries). Major estuaries: Arnhem Bay and the Cato, Blyth, Liverpool, and Glyde Rivers.

Region Code	Data Attribute	Description
BAT	NSW/53	Batemans Bay Shelf
	Climate:	Moist cool temperate with warm summers and no seasonal pattern of rainfall.
	Oceanography:	Coastal oceanographic circulation is influenced mainly by coastally trapped waves setting northwards. The median density of the seawater is 26.31, with a quartilic range of 0.19. The wave climate is characterised by a range of typical breaker heights between 1.4 and 2.9 m, and a low relative frequency of peak wave energy fluctuations, with a peak of wave energy occurring in June.
	Geology and geomorphology:	The main geological province bordering the coastline is the Lachlan Fold Belt. The continental shelf shows a very steep inshore (0–20 m), with a less steep inner- (20–60 m) to mid- (60–120 m) shelf and a generally flatter outer shelf plain (120–160 m). The narrowing trend of the shelf width continues to Montague Island (36°15'S), where the shelf is only 17 km wide. From the shoreline to about 60 m, the seafloor surface sediments are mainly well sorted. Between 60 and 120m the sediments range from muds, to muddy sands and sands, and seaward of 120m the sediments are coarser but still poorly sorted consisting mainly of carbonate-rich sands and gravels.
	Biota:	The fauna is characterised by distinctive species assemblages of reef fishes, echinoderms, gastropods and bivalves.
	Estuaries:	The relatively small estuaries in this region are predominantly of the saline coastal lagoon type.
BGS	Tas/45	Boags
	Climate:	Cool temperate, meso-thermal climate with cool wet winters and warm summers. Oceanography: Mean water temperature 19°C in summer, 12°C in winter. Moderate wave exposure. High tidal range (3 m) and strong tidal currents at eastern and western extremities.
	Geology & geomorphology:	Highly diverse geological strata, including granite and dolerite in east, basalt and quartzwacke in central region and sandstone and quartzite in west. Gradual offshore bathymetric slope into central Bass Strait.
	Biota:	Fish diversity high compared with other Tasmanian regions, algal diversity moderate. Differs substantially from other Tasmanian coastal waters by possessing large beds of the seagrasses *Posidonia australis* and *Amphibolis antarctica*, and a number of dominant species on reefs that are rare or absent further south, including the macroalgae *Cystophora monilifera* and *Sargassum varians*, the sea star *Plectaster decanus*, and the fishes *Parma victoriae*, *Meuschenia hippocrepis* and *Meuschenia flavolineata*.
	Estuaries:	One large drowned river valley (Tamar) and 21 moderate-size barrier estuaries grading into drowned river valleys.
BON	NT/19	Bonaparte Gulf
	Climate:	Climate is monsoon tropical. Rainfall averages 1200 mm in the south to over 1800 mm in the north.
	Oceanography:	Oceanic currents are influenced by the Indonesian Throughflow and the South Equatorial Current. Near shore currents are generally easterly in the wet season (October to March) and westerly in the dry season (May to September). Waters are generally of low turbidity with sea surface temperatures varying 4–5°C annually. Tidal range is micro-tidal offshore (2–3 m variation) rising to meso-tidal inshore (3–4 m variation).

Region Code	Data Attribute	Description
	Geology and geomorphology:	Geology is dominated by Permian siltstones, sandstones, limestones of the Bonaparte Basin. Patch reefs are widely scattered, particularly along the Sahul Shelf. Benthic sediments are dominated inshore by biogenic gravels and sands grading to biogenic muds offshore. Subsurface sediments are highly prospective for petroleum.
	Biota:	Little is recorded concerning marine wildlife. Trawl by-catch data indicates that fish assemblages are distinctly different from those of the Arafura region to the east.
	Estuaries:	Nil
BRU	**Tas/47**	**Bruny**
	Climate:	Cool temperate, meso-thermal climate with cool, wet winters and mild summers.
	Oceanography:	Mean water temperature 17°C in summer, 10°C in winter, with larger annual temperature ranges in sheltered embayments. Submaximal wave exposure. Microtidal (1 m range).
	Geology and geomorphology:	Predominantly dolerite and sandstone strata. Dissected coastline with large embayments protected by peninsulas. Embayments generally shallow (<25 m) with flat seabeds; exposed shores drop quickly into deep water because of extremely narrow continental shelf.
	Biota:	Fish species-richness low compared with other Tasmanian regions, plant species-richness extremely high. Contains an unusually large component of endemic species, including the fishes *Forsterygion gymnotum*, *Brachionichthys hirsutus* and *Brachionichthys politus*, the sea stars *Patiriella vivipara* and *Smilasterias tasmaniae,* and the algae *Aeodes nitidissima* and *Cirrulicarpus polycoelioides*.
	Estuaries:	One large drowned river valley (Derwent) and 20 moderate-size barrier estuaries and 4 large coastal lagoons.
CAB	**WA & NT/21**	**Cambridge-Bonaparte**
	Climate:	Semi-arid monsoon tropical climate. Rainfall ranges from 700 mm to 1200 mm annually. Runoff is low, between 50 and 250 mm of annual rainfall. A number of large rivers (Victoria, Fitzmaurice, Ord, Durack) provide seasonal inflows. Cyclone frequency is low to moderate.
	Oceanography:	Oceanography is dominated by diurnal tidal flows. Tidal variation is approximately 6–7 m. The low topographic relief produces high tidal velocities and penetration of tidal flows up to 100 km inland. Sea surface temperatures vary 5–6°C annually. Waters are generally turbid due to tides and a predominance of fine sediments. Wave energy is moderate to low in embayments and estuaries.
	Geology & geomorphology:	The region contains three major tectonic units, the Victoria River Basin (sandstones, siltstones and dolomite) in the east, the Halls Creek Orogeny (igneous and metamorphic rocks) centrally and the Kimberley Basin (Precambrian sandstones and siltstones) in the west. These units are overlain by unconsolidated terrigenous Cainozoic sediments. The coastline is generally of low relief with extensive areas of coastal saline mud flats. Benthic sediments consist largely of terrigenous sands and muds. Sediments are contributed annually by the Pentecost, King and Ord Rivers.
	Biota:	Coasts are dominated by extensive mangrove associations. Mangals of the Bay and riverine types are common. Eighteen species typical of north-western Australia have been recorded. Dugong populations are negligible. Extensive areas of wading bird and water bird feeding habitat are associated with mangroves and mudflats in this region. Turtle nesting occurs at most of the few suitable sites in the region.

Region Code	Data Attribute	Description
	Estuaries:	The Ord River (WA) and its estuaries are important in terms of the primary production which occurs there and contribute significantly to the ecosystem of Joseph Bonaparte Gulf. Estuaries dominated by deltaic river mouths (5 of 7 estuaries in NT component) due to high volume wet season flows and sediment inputs. Major NT estuaries are those of the Keep, Victoria and Fitzmaurice Rivers.
CAN	WA/24	Canning
	Climate:	Semi-arid in the north, grading to arid in the south. There are no rivers and only a few small, seasonal creeks draining into the sea.
	Oceanography:	Inshore waters tend to be moderately clear but subject to becoming turbid during periods of spring tide. Tidal range is up to 9 m. Wave energy varies from moderate along some parts of the Dampier Peninsula coast to low within the broad shelving embayments such as Roebuck Bay. Subject to cyclonic storms.
	Geology and geomorphology:	The surface rocks of this region are Cretaceous sandstones, siltstones and shales. They outcrop along much of the coast and, in many places, form low cliffs but, along the coastal strip, they are often overlain by Cainozoic oolitic limestone or dune sands. The coast contains a wide variety of landforms. The shore consists principally of long sandy beaches between rocky headlands, backed by wide dune fields. There are many bays ranging in form from the wide, open type represented by Roebuck Bay to the more-or-less V-shaped, dune/ridge barred type represented by Lagrange Bay. Boulder fields and rock platforms are features of the shores adjacent to the rocky headlands. Extraordinarily wide intertidal sand flats are a feature of the entrances to the bays and mud flats, with mangals the general rule in the upper reaches of the bays. Each of the bay units comprises a similar suite of marine and estuarine habitats. There is one nearshore island complex, the Lacepedes, comprising Holocene sand deposits on a limestone rock platform with coral reef structures. The seabed slopes gently from the shore, except for tidal scour channels (e.g. Roebuck Deep). The shore is a carbonate sand and mud-dominated sedimentary system and it is assumed these sediments also dominate the substrates in the nearshore coastal zone.
	Biota:	The flora and fauna of this sector are typical of the north-west part of the Northern Australian region. However, as might be expected with such varied coastal land form and habitats, invertebrate species-richness appears to be exceptionally high. With 8 species of mangrove, mangals of the sector are floristically less diverse than the mangals in the subhumid North Kimberley. Mangals are well developed in the upper parts of the bays and along tidal creeks, the largest and most structurally complex being in Roebuck Bay which has wide fronting intertidal mud flats and wide supratidal flats behind. Features of the coast are the wide sand flats of the open coast shores which support a rich burrowing invertebrate fauna. Subtidal seagrass beds are extensive in these areas (dugong habitat). Reef-building corals are present on most rocky shores but there are no coral reefs except that around the Lacepede Islands.
	Estuaries:	There are a series of estuaries in this area. A few have substantial associated areas of diverse wetlands that would provide habitat for estuarine and offshore fish stocks and contribute significantly to the local ecology. Those in close proximity to Broome are of local importance as recreational fishing grounds.

Region Code	Data Attribute	Description
CAR	NT & Qld/12	Carpentaria
	Climate:	Annual rainfall varies from 1000 mm in the south to over 1400 mm in the north. Cyclone frequency is moderate to high, the greatest frequency in the Territory.
	Oceanography:	Hydrology is dominated by an internal circulation largely isolated from major oceanic currents. Clockwise circulation is evident for most of the year, however this may be reversed late in the wet season, particularly during intense north-westerly monsoonal episodes. Tidal range is largely micro-tidal, ranging from 1–2 m offshore to 2–3 m inshore. Variation in mean sea surface temperature displays a strong latitudinal gradient, from 4°C in the northern Gulf to 8°C in the south. Waters offshore are usually clear, although turbidity can increase during strong seasonal winds in the relatively shallow waters of the Gulf.
	Geology and geomorphology:	Structurally the region consists of the Arafura Shelf in the west and the Carpentaria Basin. Sediments are largely terrigenous and biogenic muds and sands in the east grading to biogenic muds in the north-west.
	Biota:	Little information is available on marine wildlife. Trawl by-catch indicates substantial populations of sea turtle. CSIRO research has identified seven assemblages of epibenthos and eleven assemblages of megabenthos, with greatest diversity occurring in the eastern Gulf.
	Estuaries:	Nil
CBS	Vic & Tas/51	Central Bass Strait
	Climate:	Not applicable.
	Oceanography:	Tidal velocities vary from <0.05 ms^{-1} in the central area to as high as 0.5 ms^{-1} at the margins where the islands and promontories form the western and eastern entrances to Bass Strait. Water mass characteristics are complex and vary seasonally representing the mixing of the different water masses present on the western and eastern sides of the Strait. Mean water temperature is 19°C in summer and 13°C in winter. Submaximal wave exposure.
	Geology and geomorphology:	Large marine basin contained within the continental shelf, with water depth varying from about 80 m at its centre to 50 m around the margins. Soft sediment substratum consisting of silts and muds.
	Biota:	Diverse infaunal biota, consisting predominantly of crustaceans, polychaetes and molluscs.
	Estuaries:	Nil
COB	NT/58	Cobourg
	Climate:	Climate is monsoon tropical with annual rainfall averaging from 1200–1400 mm. Runoff is between 500–100 mm of annual rainfall, however no major rivers occur along the coastline of this region. Cyclone frequency is low to moderate.
	Oceanography:	The region is meso-tidal with a 2–3 m variation although north-east of Croker Island micro-tidal conditions(<1 m variation) apply. Currents are generally easterly in the wet season (October to March) and westerly in the dry season (May to September). Annual sea surface temperature variation is approximately 5°C. Turbidity is lower than other Territory coastal regions due to meso- and micro-tidal conditions and the lack of significant stream inputs. Deeply incised bays provide substantial shelter from strong seasonal winds, with a resulting mild wave climate along much of the coastline.

Region Code	Data Attribute	Description
	Geology and geomorphology:	Geology is dominated by lateritised Cretaceous siltstones, sandstones and mudstones of the Bathurst Island Formation. The coastline consists of deeply incised bays terminating in beaches or muddy mangrove creeks. Coastal relief is low with numerous rocky headlands with fringing coral and coralline algal reefs. Rocky patch reefs are common offshore. Numerous islands occur in the eastern portion of the region, the largest being Croker Island. The majority of islands are rocky, continental islands with fringing reefs, however coral cays, such as New Year Island and the Sandy Islands, also occur. Sediments are primarily biogenic sands and muds.
	Biota:	Mangrove diversity is lower than sites in the Darwin region although the locally rare mangrove palm *Nypa fruticans* is present. Coral diversity is high in this region, particularly on fringing reefs surrounding islands to the east and north-east of Croker Island. Sea turtles breed on the numerous beaches in the region. The offshore islands support numerous seabird rookeries. Substantial dugong populations occur across the region and seagrass beds are abundant inshore. The region is a major trawling ground for the Northern Prawn Fishery. Prawn by-catch data indicate that inshore (<30 m depth) fish assemblages are distinctly different from those of the Tiwi Region to the west, having similar compositions to inshore assemblages from Arnhem Land and Gulf of Carpentaria.
	Estuaries:	Estuaries dominated by funnel-shaped estuaries (6 of 7 major estuaries) with little freshwater input. Major estuaries: Popham Bay, Port
COR	SA/43	Coorong
	Climate:	Cool temperate, meso-thermal climate with cool, wet winters and warm, dry summers.
	Oceanography:	Waters are transitional warm to cold temperate, with mean sea surface temperatures varying from 14°C in winter to 19°C in summer. Offshore gradient decreases from steep to flat resulting in a gradational coastline, from high deep water wave energies at the Murray Mouth to low energies near Cape Jaffa. Tidal range, microtidal, ~ 0.8 to 1.2 m range.
	Geology and geomorphology:	Large barrier coast dominated by a gradational nearshore-offshore gradient. Comprises headlands and cliffs of Precambrian crystalline rock and metasediments and also Pleistocene dune rock cliffs, headlands, shore platforms and reefs, interspersed with Holocene pocket beaches. Southern coast dominated by a large beach-dune barrier lagoon complex comprising the extensive Coorong lagoon and Holocene beach ridge plains of Lacepede Bay. Offshore gradient traversed by the extensive Murray Canyons which extend offshore from the Murray River.
	Biota:	Marine flora and fauna typical of transitional warm to cold temperate waters (i.e. Flindersian Province). Intertidal and sublittoral fringe dominated by the brown alga, *Cystophora intermedia*. On rocky limestone shores, subtidal macro-algal communities are dominated by red algae assemblages (particularly *Osmundaria* and species of *Plocamium*), species of *Caulerpa* (particularly *C. flexilis*) and *Cystophora* (such as *C. subfarcinata, C. monoliformis* and *C. platylobium*) and *Ecklonia radiata*. Granite boulder coasts are dominated by *Scytothalia dorycarpa*, *Acrocarpia paniculata*, *Carpoglossum confluens*, and *Ecklonia radiata* on exposed coasts and species of *Cystophora* in areas of moderate wave energies. Extensive seagrass meadows occur at Kingston (Lacepede Bay). Seagrass meadows dominated by *Posidonia australis* in shallow areas, and *P. sinuosa*. Plant species diversity is moderate to low. Coorong Lagoon supports one of the largest concentrations of water birds and migratory waders in Australia. Coastal wetlands of national importance in the region include the Coorong Lagoon (including Lake Alexandrina and Lake Albert), and the Tookayerta and Finniss River.
	Estuaries:	Region dominated by the Murray River and extensive estuarine and ephemeral salt lakes of the Coorong Lagoon.

Region Code	Data Attribute	Description
CRF	Qld/5	Central Reef
	Climate:	No data on rainfall. Between 15 and 20 cyclones/decade, higher in south-eastern extremity.
	Oceanography:	Tidal range between 2 and 3 m.
	Geology and geomorphology:	The region does not lie within a major sedimentary basin, except the area offshore from Hinchinbrook Island, which lies in the Halifax Basin. Mud fraction mostly low, some moderate to high offshore from wet tropic coast and Bowen. Sediments are of highly carbonate origin. Mostly juvenile or early mature reefs, larger in mid-shelf areas. Poor reef development at the shelf edge, characterised by small submerged reefs and reef patches.
	Biota:	More than 70 genera of hermatypic corals.
	Estuaries:	Nil
CVA	Vic/50	Central Victoria
	Climate:	Moist temperate with warm summers
	Oceanography:	Amplitudes and phases increase eastwards. Semi-diurnal constituents dominate over diurnal constituents. Generally eastwardly decreasing velocity for the M^2 semi-diurnal constituent. Other semi-diurnal and diurnal velocities fluctuating but slowly increasing eastward. Mean annual sea-surface temperature is approximately 15.5°C representative of Bass Strait waters. Moderate wave energy (9–18 kW/m) can be divided into Cape Otway to Point Lonsdale (9 kW/m) which faces south-east and is protected from the dominant swell direction; and Point Lonsdale to Wilsons Promontory (18 kW/m), which faces south-west and receives some of the south-westerly swell.
	Geology & geomorphology:	Dominated by cliffed shorelines in Quaternary, Tertiary and Mesozoic sediments. Contains the western-most occurrence of granites and granodiorites. Orientation changes from facing south-east (Cape Otway to Point Lonsdale) to generally south-west facing (Point Lonsdale to Wilsons Promontory). Pronounced variations in orientation (over 90°) in the Venus Bay area. Very steep offshore gradients to the 20 m contour (1:50) and steep to the 50 m contour (1:100). Minor flattening out between the 20 and 50 m contours in the region offshore from approximately Port Phillip Heads to Cape Paterson.
	Biota:	Marine fauna and flora are typically cool temperate. Sheltered rock platforms are covered in a mixed algal assemblage including various green (e.g. *Codium, Caulerpa*), brown (e.g. *Cystophora, Sargassum*) and red algae. This assemblage continues into the shallow subtidal (5–20 m) on south-east facing coasts such as off Point Lonsdale and the Bunurong. The more exposed coasts are fringed with *Durvillaea* with mixed *Phyllospora* and *Ecklonia* stands occurring on subtidal reefs. Small beds of *Amphibolis antarctica* seagrass occur on sand in sheltered locations. Many western species have their eastern distribution limit within central Victoria particularly between the Bunurong and Wilsons promontory.
	Estuaries:	See VES–Victorian Embayments
CWC	WA/33	Central West Coast
	Climate:	Temperate with a moderate rainfall and several small
	Oceanography:	River discharge has a minor effect on coastal waters which are moderately clear. There is a cool northward current, the Capes Current, flowing nearshore and northward along this coast in summer, and a warm southward flowing current, the Leeuwin Current, offshore in late summer to winter. Tides are diurnal with a maximum range of 1 m and wave energy is moderate to high.

Region Code	Data Attribute	Description
	Geology & geomorphology:	This coast is formed over the Perth Sedimentary Basin. Through the Pleistocene there has been a succession of transgressions and regressions of the sea over the Swan Coastal Plain. Each regression has left a coastal dune field and the oldest of these have consolidated to form N–S aligned ridges of aeolianite limestones. Ridges above present day sea level usually bear a mantle of Holocene dunes. Those below it form sublittoral reefs, often undercut and cavernous. The shore is commonly long sandy beaches with occasional rocky cliffs and headlands where the aeolianites outcrop. Small islands representing high points of flooded ridges are common nearshore. Notched intertidal rock platforms are a feature of this coast. Semi-sheltered lagoonal habitats are developed behind off-shore limestone reefs in many localities. Cockburn Sound is a major, enclosed marine embayment. Jurien Bay, Warnbro Sound and Geographe Bay are major but more open embayments. The shelf adjacent to this coast is dominated by bioclastic carbonate and quartz sediments. Cockburn and Warnboro Sounds have muddy central basins.
	Biota:	The flora and fauna of this sector are predominantly of southern Australian affinity but with a strong Indo–west Pacific influence through the agency of the Leeuwin Current which carries propagules of tropical species far into temperate latitudes. This extended distribution is exemplified by hermatypic corals, many species of which occur as individual corals as far south as Geographe Bay and beyond, though not forming coral reefs. Tropical fish species occur as far south as Rottnest Island and tropical seagrass species such as *Halophila spinulosa* and *Syringodium isoetofolium* are found at Cliff Head and Warboro Sound respectively, some 5 degrees of latitude further south than on the east coast of Australia. There is also a strong West Coast endemic element in the fauna. In this area, the species diversity of seagrass is the highest in the world with 14 species represented. Seagrass meadows are well developed in less exposed areas, especially in Geographe Bay and Warnboro Sound and in the inter-reef lagoons along exposed sections of the coast. There is a relict mangal, consisting solely of *Avicennia marina*, in Leschenault Inlet. The reefs of Rottnest Island are the type locality for many species of algae. In the intertidal and shallow sublittoral communities of the south-west coast is found a conspicuous relict of the ancient fauna of the Tertiary period. The gastropod *Camponile symbolicum*, is a 'living fossil' and the sole survivor of the family Campanilidae which flourished in the Tethys Sea.
	Estuaries:	There is one large estuary and several smaller estuaries on the Central West Coast. The Swan Estuary is large and permanently open to the sea. It supports a depauperate fauna and flora, consisting of a few obligate estuarine species and a large number of marine species that invade the estuaries opportunistically in summer. The Swan Estuary has a very high conservation value in terms of recreational use and as scientific and educational resources. In summer this estuary is significant as a nursery area for commercial and recreational fisheries of crustacea and marine fishes and provides very important feeding areas for migratory wading birds. This estuary is threatened by eutrophication due to development, agriculture and the proximity of populous urban areas. Smaller estuaries exist at the mouths of the Murchison, Greenough, Irwin and Hill rivers.

Region Code	Data Attribute	Description
DAV	Tas/46	Davey
	Climate:	Cold temperate, meso-thermal climate with cold winters, cool summers and very high rainfall.
	Oceanography:	Mean water temperature 17°C in summer, 11°C in winter. Maximal wave exposure. Microtidal (1 m range).
	Geology & geomorphology:	Quartzitic coastline with numerous rocky headlands separated by sandy beaches. Narrow continental shelf.
	Biota:	Fish species-richness low, plant species richness moderately high. Contains the most extensive stands of giant kelp (*Macrocystis pyrifera*) remaining in Australia, and is the only location where the striped trumpeter (*Latris lineata*) is regularly recorded. A number of endemic species, including new species of fish, molluscs and cnidarians, appear restricted to the Port Davey embayment within the region.
	Estuaries:	One large drowned river valley (Bathurst Harbour) and 5 moderate-size barrier estuaries grading into drowned river valleys.
ECY	Qld/8	East Cape York
	Climate:	Rainfall between 1400 mm and 2000 mm, except less than 1400 mm in Princess Charlotte Bay. Between 10 and 15 cyclones/decade, lower in the north.
	Oceanography:	Tidal range between 2 and 4 m.
	Geology & geomorphology:	The area does not lie within a major sedimentary basin, except the Laura Basin in the Flinders Group area. Mud fraction within sediments is mostly high. Sediments are mostly of highly carbonate origin, transitional along the coast. Medium sized planar or lagoonal reefs, with senile reefs, shoals, low wooded cay reefs and some planar reefs in Princes Charlotte Bay.
	Biota:	Twenty-seven mangrove trees species, 37 tree plus understorey species, 6 saltmarsh species. Forms tall, very complex closed forest communities, although stunted or open communities found in marginal areas. More than 70 genera of hermatypic corals.
	Estuaries:	
EMB	WA/25	Eighty Mile Beach
	Climate:	Arid, without any modern rivers entering the sea.
	Oceanography:	Wave energy is low to moderate but subject to cyclonic storms and the tidal range is up to 8 m.
	Geology and geomorphology:	This sector represents the southern half of the Canning Basin coast. The geology comprises Cretaceous sedimentary rocks, overlain along the coast by Cainozoic dune sands. The Cainozoic deposits represent a current phase of marine transgression over the flat, low-lying plains of the Canning Basin. A feature of the hinterland is the presence of two fossil river beds that once drained the Canning Basin. These are covered by the Cainozoic deposits along the shore. The beach is arcuate and almost continuous, broken only by a few small bays with sparse mangal, it consists of siliceous sand and it is assumed that this sediment continues across the inner shelf slope. It is fronted by tidal flats, sometimes several km wide, and backed by dune fields. Seaward the sea floor slopes gently and more or less evenly far beyond the limit of WA State waters.
	Biota:	There is no information on the invertebrate fauna of this shore or the subtidal seabed beyond it. However, beach drift indicates a rich burrowing and epibenthic fauna. Parts of the beach are an important migratory shorebird habitat and designated under RAMSAR Convention as a Wetland of International Importance.
	Estuaries:	Nil

Region Code	Data Attribute	Description
EUC	WA & SA/37	Eucla
	Climate:	Semi-arid or `Mediterranean' climate, with hot, dry summers and cool, moist winters.
	Oceanography:	Waters are transitional warm to cold temperate, with mean sea surface temperatures varying from 14°C in winter to 19°C in summer (increasing to 22°C in summer under the seasonal influence of the warm water Leeuwin Current). Open moderate to high wave energy, west-facing coastline. High wave swell environment, 2–4 m. Tidal range, microtidal ~ 0.8–1.2 m range.
	Geology & geomorphology:	Rocky cliff coastline, with a shallow offshore gradient, dominated by bio-clastic carbonate sediments. Coastal geology characterised by the sedimentary Eucla Basin and dominated by the Nullarbor Tertiary limestone cliffs, Pleistocene dune rock headlands and reefs, interspersed with Holocene beaches and dune barriers. Narrow intertidal rock platforms are present at the base of the cliffs in some places.
	Biota:	Marine flora and fauna typical of transitional warm to cold temperate waters (i.e. Flindersian Province). Intertidal and sublittoral fringe dominated by the brown alga, *Cystophora intermedia*. On the high energy limestone reefs, subtidal macro-algal communities are dominated by *Scytothalia dorycarpa* and *Ecklonia radiata,* with species of *Cystophora* (such as *C. platylobium*) as subdominants. There are few seagrass communities along this high energy coast. Plant species diversity is moderate to low. Significant breeding and calving area of the Southern Right Whale (*Eubalaena australis*) and large number of breeding colonies of the Australian Sea Lion (*Neophoca cinerea*). Distinct tropical element in the fauna and flora of the region (i.e. plankton, fish, echinoderms, hydroids), due to the warm water Leeuwin Current.
	Estuaries:	Nil
EYR	SA/39	Eyre
	Climate:	Semi-arid or `Mediterranean' climate, with hot, dry summers and cool, moist winters.
	Oceanography:	Waters are transitional warm to cold temperate, with mean sea surface temperatures varying from 14°C in winter to 19°C in summer (decreasing to 11–12°C under the influence of localised, cold nutrient-rich coastal upwellings). Moderate to high deepwater wave energy coastline. Tidal range, microtidal ~ 0.8 to 1.2 m range.
	Geology & geomorphology:	Rocky coast with a shallow to moderate offshore gradient, with numerous headlands and sheltered, extensive shallow embayments, dominated by seagrasses. Coastal geology on exposed rocky coasts comprises Precambrian metasediment cliffs and also Pleistocene dune rock cliffs, headlands and shore platforms, interspersed with Holocene dune barriers beaches and lagoon deposits in sheltered areas. Cainozoic colluvial and fluvial sediments. Numerous offshore islands and seamounts.
	Biota:	Marine flora and fauna typical of transitional warm to cold temperate waters (i.e. Flindersian Province). Intertidal and sublittoral fringe on rocky shores dominated by the brown alga, *Cystophora intermedia*. On rocky limestone shores, subtidal macro-algal communities are dominated by red algae assemblages (particularly *Osmundaria* and species of *Plocamium*), species of *Caulerpa* (i.e. *C. flexilis*) and *Cystophora* (such as *C.subfarcinata*, *C. monoliformis* and *C. platylobium*) and *Ecklonia radiata*. In sheltered areas, subtidal seagrass communities dominated by *Posidonia australis* in shallow waters, and *P. sinuosa, P. angustifolia, Amphibolus antarctica* and *A. griffithsii* in deeper waters. Plant species diversity is high, particularly among the red algae. Marine fish fauna characterised by the presence of the SA endemic, Crested Threefin (*Norfolkia cristata*). Significant breeding colonies of the Australian Sea Lion (*Neophoca cinerea*) and New Zealand Fur Seal

Region Code	Data Attribute	Description
		(*Arctocephalos forsteri*), particularly on the offshore islands. Coastal wetlands of national importance in the region include, Streaky Bay (Acraman Creek), Point Labatt, Baird Bay, Lake Newland, Lake Hamilton, Coffin Bay, Tod River, Tumby Bay, on the Eyre Peninsula and D'Estres Bay, Rocky River, Breakneck River, North West River, South West River on Kangaroo Island.
	Estuaries:	No true rivers, but several intermittent streams (e.g. Tod River, First Creek on Eyre Peninsula, and Stun'sail Bloom, Breckneck, Rocky, Wilson, Eleanor, Harriet, South West Rivers on southern Kangaroo Island) and coastal salt lakes (e.g. Lake Newland, Lake Hamilton).
FLI	**Vic & Tas/49**	**Flinders**
	Climate:	Cool temperate, meso thermal climate with cool wet winters and warm summers.
	Oceanography:	Mean sea-surface temperature varies from 20°C in summer to 13°C in winter. Submaximal wave exposure which is highly variable especially on Wilsons Promontory with wave energy of 18 4kW/m on the western side to 4 kW/m on the eastern side where it is protected from the dominant south-west swell direction. Tidal characteristics (velocities and amplitudes) vary markedly across the region as determined by the geometry of the eastern entrance to Bass Strait. Tidal range varies from 2–3 m with the greatest range occurring between the islands in the southern part of the region.
	Geology and geomorphology:	Predominantly granite (Wilsons Promontory, Flinders and other islands) and unconsolidated clastic sediments. Rocky headlands and promontories are prevalent with long sandy beaches between. Located on the continental shelf on the eastern entrance to Bass Strait. Low offshore slopes and extensive offshore reef systems often present in the south but shores plunge steeply onto sandy sea floor to the north around Wilsons Promontory.
	Biota:	Fish and plant species-richness both high, when compared with Tasmanian regions. The biota is typical of the Bassian province, with warm-temperate species commonly found in New South Wales also present in low numbers.
	Estuaries:	Most estuaries are in the Furneaux Group, which has nine moderate-size estuaries and numerous coastal lagoons. Shallow Inlet, the only major lagoon west of Wilsons Promontory, lies at the northern end of the region. See also VES–Victorian Embayments
FRA	**Tas/57**	**Franklin**
	Climate:	Cold temperate, meso-thermal climate with cold winters, cool summers and extremely high rainfall.
	Oceanography:	Mean water temperature 17°C in summer, 12°C in winter. Maximal wave exposure. Microtidal (1 m range).
	Geology and geomorphology:	Diverse geological coastal strata with turbidites predominating in south and sandstones/mudstones and granites in northern section. Rocky headlands separated by very long sandy beaches. Narrow continental shelf.
	Biota:	Fish diversity extremely low, algal diversity moderately low. Differs from other regions primarily by low species-richness. No plants or animals recognised to be characteristic.
	Estuaries:	One large drowned river valley (Macquarie Harbour) and 15 moderate-size drowned river valleys grading into barrier estuaries.

Region Code	Data Attribute	Description
FRT	Tas/48	Freycinet
	Climate:	Cool temperate, meso-thermal climate with cool wet winters and warm summers.
	Oceanography:	Mean water temperature 17 °C in summer, 12 °C in winter. Experiences significantly elevated temperatures on occasions when warm core eddies produced by the East Australian Current move inshore. Submaximal wave exposure. Moderate (1.5 m) tidal range.
	Geology and geomorphology:	Predominantly granitic coastline which is interrupted by clastic sedimentary sequences. Coastal embayments present in Mercury Passage and Oyster Bay. Narrow continental shelf.
	Biota:	Fish species-richness moderate compared with other Tasmanian regions, plant species richness moderately high. A number of warm temperate species common in New South Wales but rare in Bass Strait recruit in variable numbers each year, including the fish *Parma microlepis*, the sea urchin *Centrostephanus rodgersii*, the crustaceans *Austromegabalanus nigrescens* and *Penaeus plebejus*.
	Estuaries:	Nineteen moderate-size barrier estuaries and drowned river valleys. Numerous coastal lagoons including six of moderate-size.
GRO	NT/14	Groote (was N W Gulf of Carpentaria)
	Climate:	Monsoon tropical with rainfall of 1000–1200 mm annually. Cyclone frequency is moderate. Run off is 125–250 mm of annual rainfall. No major rivers discharge in this region.
	Oceanography	Ocean circulation in the Gulf of Carpentaria is dominated by a largely internal clockwise current. Current reversal may occur as a result of prolonged north-west monsoonal incidents during the wet season (November to March). Inshore waters are often turbid due to fine grained sediments, strong seasonal winds and shallow waters. Tidal range is meso-tidal (2–3 m variation) while annual sea surface temperature variation is approximately 7–8°C.
	Geology and geomorphology:	Geology is dominated by Precambrian sandstones and siltstones of the Caledon shelf with igneous outcrops (granite, granodiorite) on the north-eastern coast. Coastal relief is generally low with some lateritic and quartz calcarenite cliffs in the Gove Peninsula and Cape Arnhem. Coastal dunes to 50 m height occur at Cape Arnhem. Sediments consist of sandy muds inshore, particularly around Groote Eylandt and in Caledon Bay, grading to fine muds offshore.
	Biota:	Mangrove diversity is relatively low (15–26 species dependent on location), with a narrow mangrove fringe in many areas. Coral reefs are sparsely distributed, however fringing coral reefs are well developed at Groote Eylandt. Extensive seagrass beds are found along the mainland coast and around Groote Eylandt. Dugongs are widely distributed through the region, and populations of the Irrawaddy dolphin are common, with high densities in Blue Mud Bay.
	Estuaries:	Diverse range of estuary types reflect a diversity of hydrological and sedimentation regimes. Spit-lagoon estuaries are most common (5 of 16 major estuaries) Double spit barrier enclosed estuaries (2 of 16), beach enclosed estuaries (2 of 16), straight-banked river mouths (2 of 16) and deltaic river mouths (2 of 16) are also present.
		Major estuaries: Melville Bay, Port Bradshaw, Koolatong River, Hart River, Rose River.

Region Code	Data Attribute	Description
HAW	NSW/54	Hawkesbury Shelf
	Climate:	Warm temperate, with warm to hot summers and no significant seasonal pattern of rainfall.
	Oceanography:	Coastal oceanographic circulation is influenced mainly by meso-scale eddies of the East Australian Current flowing southwards and coastally trapped waves setting northwards. Coral Sea and Tasman Sea water masses meet in this region, forming the tasman Front. The median density of the seawater is 26.20, with a quartilic range of 0.58. The wave climate is characterised by a range of typical breaker heights between 1.4 and 2.5 m, and a high relative frequency of peak wave energy fluctuations, with a primary peak of wave energy occurring in May and a secondary one in February.
	Geology and geomorphology:	The main geological province bordering the coastline is the Sydney-Bowen Basin. The continental shelf is very steep inshore (0–20 m), with a less steep inner (20–60 m) to mid shelf (60–120) and generally flatter outer shelf plain (120–160 m). The maximum width of the shelf is attained in the Newcastle area (72 km), narrowing southwards to 26 km off Botany Bay. The inner shelf region to 60-70m consists of drowned sand barriers on more gently sloping sectors, and headland attached shelf sand bodies off protruding sectors of coasts where the substrates are steeply sloping. The mid-shelf area to 120m consists of muddy sands and muds whilst the outer shelf plain to seawards is dominated by calcareous sands and shell gravels.
	Biota:	The fauna is characterised by distinctive species assemblages of reef fishes, asteroids, echinoderms, gastropods and bivalves.
	Estuaries:	The larger estuaries in this area are predominantly of the drowned river valley type.
KAN	Qld/11	Karumba-Nassau
	Climate:	Monsoon Tropical. Rainfall about 100 mm. Between 5 and 15 cyclones/decade.
	Oceanography:	Tidal range between 3 and 4 m, from diurnal in the south to semidiurnal in the north. Lies within coastal boundary layer of Gulf, not greatly affected by clockwise circulation of Gulf water mass.
	Geology & geomorphology:	Lies within Carpentaria sedimentary basin. Mud fraction mostly low except moderate at the mouths of major rivers and in the south in the Karumba area. Sediments of terrigenous origin. Shoreline essentially flat coastal terraces, grading into supratidal saltflats and claypans, extending for over 50 km in the south, but narrowing markedly in the north. No major reef structures.
	Biota:	Twelve mangrove tree species, 17 tree plus understorey species, 10 saltmarsh species. Forms a dense coastal or riverine fringe, backed by wide (20 km or more) saltpans. Very significant saltwater crocodile, dugong, turtle and seabird habitat.
	Estuaries:	Several major river systems, including Gregory, Leichhardt, Saxby, Norman, Gilbert, Staaten, Mitchell and Coleman. Northern rivers mostly meander through coastal floodplains and retain sufficient freshwater inflow in the dry season to avoid hypersalinity. Southern streams tend to have more direct flows and openings, and are usually subject to hypersalinity in the dry season.

Region Code	Data Attribute	Description
KIM	WA/22	Kimberley
	Climate:	The sector has a high but seasonal rainfall and there are many large rivers which flood annually. The rainfall decreases south from Walcott Inlet.
	Oceanography:	This coast is characterised by low-energy conditions, except for occasional severe cyclonic storms. With a tidal range up to 11 m the inshore areas are dominated by strong tidal flows and coastal waters are turbid.
	Geology and geomorphology:	The Kimberley is essentially a dissected plateau (the Kimberley Plateau Province). Much of the north and west Kimberley is dominated by Proterozoic Kimberley Group sandstones and siltstones. Similar Proterozoic Speewah Group sandstones and siltstones outcrop at the coast in Yampi Sound and Buccaneer Archipelago. Kimberley Group Carson Volcanics outcrop at a number of locations around the coast, notably Cape Londonderry, Cape Bouganville, the south-western shore of Admiralty Gulf, Cape Torres, and within St George Basin, Camden Sound and Walcott Inlet. The Kimberley has a ria coast with high relief, deep embayments and many islands, providing spectacular coastal scenery and a wide range of coastal marine and estuarine habitats. There are two distinct types of coastal geomorphology. The flat-bedded Speewah and Kimberley Group sandstones and siltstones tend to erode as breakaway cliffs with scree slopes of boulders. These form the shore in many places, although there is often a narrow zone of Holocene sands in the more open bays, and wide alluvial mud flats in the sheltered bays and gulfs. The Kimberley Group Carson Volcanics erode to rounded hills forming shores backed by rocky slopes. Nearshore Kimberley islands may be of either sandstone/siltstone or Carson Volcanics and their structure and appearance vary accordingly. Terrigenous muds dominate the shores and the inner part of the continental shelf.
	Biota:	The marine flora and fauna are typical of the North West Province of the Northern Australian region. Mangals are very well developed, especially in land-locked bays such as St George Basin. As well as being structurally complex the mangals are floristically rich in mangrove species (16 recorded) and support a diverse fauna. Though there has been no analysis of the matter, it seems that there is a higher number of mangal invertebrates with Central Indo–West Pacific affinities than is present in the Canning and Pilbara mangals. Coral reefs occur but are not usually well developed, except around offshore islands. An exception are the coral reefs of the inner Buccaneer Islands which are species-rich and extensive.
	Estuaries:	There are many estuarine systems of varying ecological importance with diverse floral and faunal assemblages in this area. Some estuaries are important as feeding areas for large numbers of water birds and as refuge for the salt water crocodile.
KSD	WA/23	King Sound
	Climate:	Semi-arid tropical.
	Oceanography:	Dominance of mud and the extreme tidal range result in turbid waters in the Sound throughout the year, except close to the mouth where the water may be moderately clear during neap tide periods. Wave energy is low, but subject to cyclonic storms and the tidal range is very large, up to 11 m.
	Geology & geomorphology:	The Sound is bounded on the west and south by the Canning Basin with its Mesozoic sediments, and on the north-east by metamorphic and sedimentary rocks of the King Leopold Oregon. Cainozoic alluvial deposits overlie these strata along much of the coastal strip. The western shore has low relief with a narrow mangal fringe and supratidal flats, merging into vegetated sand dunes. The southern shore has exceptionally wide supratidal flats and the landward limit of tidal water is hard to define. There are wide mangals in the bays of the eastern shore. Mud, sand and gravel flats dominate the shore types but in the north-east there is local development

Region Code	Data Attribute	Description
		of rocky shores as the system grades into the ria shore complex of the Kimberley coast. The subtidal substrate of the Sound consists of deep terrigenous mud.
	Biota:	The marine and estuarine flora and fauna of King Sound have not been comprehensively studied but appear to be typical of the north-western part of the Northern Australian region. There may be some peculiarities in the estuarine community structure relating to the seasonality of the estuarine upper parts and the semi-arid climate. Seagrass beds occur in the shallows at the mouth of the Sound (dugong habitat) but there is no information on their floristic composition. Benthic invertebrate and fish faunas in that area appear to be diverse but there are no details.
	Estuaries:	The upper part of the Sound has features of a seasonal estuary receiving waters from the Fitzroy, May and Meda rivers, and seaward it merges into a marine gulf habitat.
LMC	Qld/4	Lucinda–Mackay Coast
	Climate:	Rainfall mostly between 1000 mm and 1400 mm, except 1400 mm to over 2000 mm in the Whitsundays-Mackay area. Between 10 and 15 cyclones/decade, slightly higher in Whitsundays.
	Oceanography:	Tidal range mostly between 3 and 4 m, up to 6 m at southern end.
	Geology & geomorphology:	The area does not lie within a major sedimentary basin, except the Proserpine Basin in the Repulse Bay area. Sediments are mostly of terrigenous origin, some transitional in areas immediately north and south of the Whitsundays.
	Biota:	Twenty mangrove tree species, 25 tree plus understorey species, 8 saltmarsh species. Forms lower closed to open forest communities along sheltered coasts and rivers. More than 70 genera of hermatypic corals.
	Estuaries:	TBA (to be advised)
LNE	WA/34	Leeuwin-Naturaliste
	Climate:	Temperate with moderate rainfall.
	Oceanography:	The water is clear. A cool northward current flows nearshore along this coast in early summer. The warm southward-flowing Leeuwin Current reaches this shore during late summer, and winter in some years. The water on the west side of Cape Naturaliste may be several degrees warmer than that in Geographe Bay. The tide is diurnal and the range is less than 1 m. This is a high energy coast exposed to heavy wave action driven by the West Wind Belt.
	Geology & geomorphology:	This sector represents the shores of the elevated block known as the Leeuwin Block, bounded on the east by the Dunsborough Fault which separates the block from the sedimentary sinkland known as the Perth Basin, and intercepting the coast at Dunsborough and Flinders Bay. The Leeuwin Block consists of intensely deformed, Precambrian plutonic igneous rocks, mainly granites and granulites. Although the igneous rocks of the Leeuwin Block are considerably younger than those of the Yilgarn Block and Albany-Frazer Oregon, they form similar shores. The Leeuwin-Naturaliste shoreline is characterised by high granitic headlands with curving sandy beaches between. In many places there are cliffs and rock platforms developed in superficial Quaternary aeolian limestone deposits between or below the granite headlands. Off-shore the sediments are primarily bioclastic carbonates and quartz sands.

Region Code	Data Attribute	Description
	Biota:	The biogeographic affinities of the marine flora and fauna of this coast lie strongly with the Southern Australian region and both community species composition and structure are much like those of the similar habitats on the South Coast. The south-west endemics are equally represented. However, there is a stronger Indo–West Pacific element, believed to be through the influence of the Leeuwin Current, and some southern species fail to penetrate around Cape Leeuwin.
	Estuaries:	There are several estuaries, of which three, the Peel-Harvey, Leschenault and Hardy Inlet are large and are permanently open to the sea. The larger estuaries support a depauperate fauna and flora, consisting of a few obligate estuarine species and a larger number of marine species that invade the estuaries opportunistically in summer. The Peel-Harvey Estuary is a Designated Wetland of International Importance under RAMSAR (Convention on Wetlands of International Importance Especially as Waterfowl Habitat). All three estuaries have a very high conservation value in terms of recreational use and as scientific and educational resources. In summer these estuaries are significant as a nursery area for commercial and recreational fisheries of crustacea and marine fishes and provides very important feeding areas for migratory wading birds. They are threatened by eutrophication due to development, agriculture and the proximity of populous urban areas. Smaller estuaries exist at the mouths of the Vasse, Margaret, Donnelly and Warren rivers.
MAN	NSW/55	Manning Shelf
	Climate:	Warm temperate with hot summers and predominantly summer-autumn rains.
	Oceanography:	Coastal oceanographic circulation is dominated by the main stream of the East Australia Current (EAC). However, this is the area where for most of the time (65.6%) the EAC breaks away from the NSW continental shelf in a south-easterly direction. Localised centres of upwelling (24 day upwelling cycles) are found during spring and summer off Laurieton (31°39'S). Their effects on the nutrient loading of the area are similar to the effects of the upwelling areas off Evans Head. The median density of the seawater is 25.72 with a quartilic range of 0.43. The wave climate is characterised by a range of typical breaker heights between 1.4 and 2.5 m, and a high relative frequency of peak wave energy fluctuations, with a primary peak of wave energy occurring in May and a secondary one in February.
	Geology and geomorphology:	The main geological province bordering the coastline is the New England Fold Belt. The continental shelf shows a relatively steep inner shelf (0–80 m), with a flatter mid shelf plain (80–120 m) and a relatively steeper outer shelf (120–160 m). The width of the continental shelf ranges between 25 km (north of 31°30'S) to 50 km (south of 31°30'S). The inner shelf region to 60-70m consists of drowned sand barriers on more gently sloping sectors, and headland attached shelf sand bodies off protruding sectors of coasts where the substrates are steeply sloping. The mid-shelf area to 120m consists of muddy sands and muds whilst the outer shelf plain to seawards is dominated by calcareous sands and shell gravels.
	Biota:	The fauna is characterised by distinctive species assemblages of reef fishes, echinoderms, gastropods and bivalves.
	Estuaries:	The estuaries of the large coastal rivers in this region are predominantly of the sand barrier type.

Region Code	Data Attribute	Description
MCN	Qld/3	Mackay-Capricorn
	Climate:	No data on rainfall. Between 15 and 20 cyclones/decade.
	Oceanography:	Tidal range between 3 and 6 m. Greatest range in the middle of the region, lesser at the extremities.
	Geology & geomorphology:	No major sedimentary basin within the area. Mud fraction in sediments moderate to high, except low in inner reef area (Capricorn-Bunker Group and shoal grounds to the north). Sediment origin is highly carbonate, except a small terrigenous area offshore from Keppel Bay.
	Biota:	From 60 to just more than 70 genera of hermatypic corals.
	Estuaries:	Nil
MUR	SA/38	Murat
	Climate:	Semi-arid or `Mediterranean' climate, with hot, dry summers and cool, moist winters.
	Oceanography:	Waters are transitional warm to cold temperate, with mean sea surface temperatures varying from 14°C in winter to 19°C in summer (increasing to 22°C in summer under the seasonal influence of the warm water Leeuwin Current). Moderate to low wave energy coastline. Tidal range, microtidal ~ 0.8 to 1.2 m range.
	Geology & geomorphology:	Rocky crenulate coastline, with a shallow offshore gradient, numerous shallow sheltered embayments, dominated by seagrasses. Coastal geology comprising headlands of Precambrian crystalline rock (usually with a dune rock capping), and Pleistocene dune rock cliffs, reefs and headlands, interspersed with Holocene beaches, dunes and estuarine deposits including intertidal and supratidal flats. Numerous offshore islands and seamounts.
	Biology:	Marine flora and fauna typically warm temperate (i.e. Flindersian). Extensive seagrass communities in embayments and lee of islands. On sandy shores, in sheltered areas, intertidal flats are dominated by the grey mangrove, *Avicennia marina*, the brown alga, *Hormosira banksii*, and the seagrasses, *Heterozostera muelleri* and *Zostera tasmanica*. Subtidal seagrass communities dominated by *Posidonia australis* in shallow waters, and *P. sinuosa, P. angustifolia, Amphibolus antarctica* and *A. griffithsii* in deeper waters. On rocky shores, exposed limestone coasts are dominated by *Ecklonia radiata* and *Scytothalia dorycarpa*. In calmer areas, macro-algal communities are dominated by *Sargassum* and *Osmundaria* on moderate coasts and *Scaberia agardhii* in low wave energy conditions. Granite boulder reefs are dominated by *Scytothalia dorycarpa* and species of *Cystophora* (such as *C. monoliformis*). Plant species diversity is moderate to low. Distinct tropical element in the fauna and flora of the region (i.e. plankton, fish, echinoderms, hydroids), due to the Leeuwin Current. Coastal wetlands of national importance in the region include Davenport Creek (Tourville Bay).
	Estuaries:	No true rivers, but a few intermittent streams and tidal mangrove creeks (e.g. Davenport Creek).

Region Code	Data Attribute	Description
NIN	WA/29	Ningaloo
	Climate:	Semi-arid with seasonal storm creeks draining into the lagoon but no rivers.
	Oceanography:	The water is clear, except in the lagoon during bad weather when the shallow water may become turbid. The southerly drift of the Leeuwin Current passes close to the reef. Tides are semi-diurnal with a maximum range (Cape Murat) of about 1.7 m. This is a moderately high-energy coast although the reef protects the shore from severe wave action
	Geology & geomorphology:	The coast comprises Tertiary sedimentary rocks and Quaternary limestones of the Carnarvon Basin. The coastal profiles take two forms in this sector—with a relatively high, hilly relief in the north and low, undulating relief in the south. The northern half lies along the seaward side of the Cape Range anticline with a high hinterland and a narrow coastal plain and fringe of Holocene dunes. There is a series of Pleistocene shorelines cut into the Tertiary limestones at different levels along the western escarpment of the Range. The shore itself is generally of narrow beach but rocky shores occur where the underlying limestones are exposed. At several locations, vegetated sand spits project seaward from the general N–S trend of the shore, forming semi-protected bays on their northern side. South of Point Cloates the hinterland has a lower relief but the shore itself is similar. The shoreline is composed of carbonate sands.
	Biota:	This reef is one of Australia's major coral reef systems and is protective, almost continuous and off-shore in the north but becomes an interrupted fringing reef in the southern part. It has rich coral growth and a moderately high species diversity; 217 species of hermatypic corals (of 54 genera) are recorded. Other invertebrate and fish communities are also moderately diverse. There are small, sparse seagrass beds in the lagoon. Little is known of the shelf fauna beyond the reef-front slope. The majority of the shallow water species in the reef and lagoon communities are widespread in the Indo–West Pacific region. In terms of biogeographic affinities, there is an abrupt change in shallow water invertebrate faunas, with few of the North West Shelf endemics extending around North West Cape to Ningaloo Reef. At the southern end of the sector, however, a number of West Coast endemic elements are present (the northern limit of their range). There are small relict mangals, comprising three species, at Mangrove Bay and Yardie Creek near the northern end of the sector.
	Estuaries:	Nil
NSG	SA/40	North Spencer Gulf
	Climate:	Semi-arid or `Mediterranean' climate, with hot, dry summers and cool, moist winters.
	Oceanography:	Confined inverse estuary, with minimal freshwater water input and higher salinities and temperatures in the upper reaches of the Gulf. Waters are transitional warm to cold temperate, with mean sea surface temperatures varying from 11–24°C at Point Lowly and 13–29°C at Port Augusta. Mean salinity increases from 42.0–44.8% at Point Lowly, to 43.2–48.6% at Port Augusta. Low wave energy coastline. Tidal range, microtidal to mesotidal 1.8 to 3.6 m range. Tides are typified by a regular period of minimal tidal movement or `dodge tide'.
	Geology & geomorphology:	Tidal plain coast comprised of shallow offshore gradients, extensive intertidal and supratidal areas dominated by samphires, mangroves, and seagrasses.

Region Code	Data Attribute	Description
		Coastal geology comprises Precambrian metasediment shore platforms, Holocene sandflats, beach ridges, recurved spits, and extensive intertidal and supratidal flats.
	Biota:	Marine flora and fauna typical of transitional warm to cold temperate waters (i.e. Flindersian Province), but with a distinct subtropical element, characterised by the presence of tropical species such as the brown alga, *Sargassum decurrens* and *Hormophysa triquetra*. In sheltered areas, intertidal flats are dominated by extensive areas of the grey mangrove, *Avicennia marina*, together with the brown alga, *Hormosira banksii,* and the seagrasses, *Heterozostera muelleri* and *Zostera tasmanica*. Subtidal areas characterised by extensive sandy substrates and seagrass meadows, dominated by *Posidonia australis* in shallow areas, *P. sinuosa*, *P. angustifolia* and *Amphibolus antarctica* in deeper waters, and small shore fringing macro-algal communities. Limited rocky areas by macro-algal communities dominated by *Scaberia agardhii*, *Lobophora, Cystophora botryoides* and C. *expansa* and *Caulocystis*. Plant species diversity very low. Sparse to no plant cover in deeper waters (>17 m), animal dominated. Coastal wetlands of national importance in the region include the upper Spencer Gulf mangroves from Port Augusta, south to Whyalla and Jarrold's Point, Fisherman's Bay and Port Broughton.
	Estuaries:	No true rivers, but many intermittent streams and tidal mangrove creeks (e.g. Chinaman Creek, First-Seventh Creeks, Port Davis Creek, Fisherman Creek).
NWS	WA/28	North West Shelf
	Climate:	An arid, tropical climate.
	Oceanography:	The water is generally clear. Wave energy is typically moderate but can be extreme during cyclones. Tides are macrotidal with spring range exceeding 5 m. Current speeds are generally high, particularly in deep waters, and the area is also influenced by the poleward flowing Leeuwin Current.
	Geology and geomorphology:	The southern portion of the NWS is a wide continental platform bordered by the Australian continent on one side and by an abyssal plain on the other. Sediments are predominantly calcareous with little sediment currently being supplied to this region.
	Biota:	The benthic invertebrate communities on the shelf are diverse and these waters support a rich pelagic and demersal fish fauna.
	Estuaries:	Nil
OSS	WA/60	Oceanic Shoals
	Climate:	Tropical monsoonal climate. The area is subject to cyclonic activity between December and April. Strong easterly to south-easterly trade winds blow at 15 to 20 knots almost continually from May to October.
	Oceanography:	Clear warm water with a temperature range from 24° in the southern sector to 30° in the north, with little variation throughout the year and only slight stratification due to the permanent shallow thermocline characteristic of the region between Java and Northern Australia. Surface salinities average 34–35 parts per thousand. Wave energy is generally moderate other than when the region is influenced by cyclones. Macrotidal to 6 m in the northern area. The influence of the Indonesian Throughflow and the Leeuwin Current is of importance in the west and north-western part of this region.

Region Code	Data Attribute	Description
	Geology & geomorphology:	Bore hole evidence indicates that carbonate deposition has occurred along the continental shelf edge in the northern sector of the region since the Eocene. This long history of reef-related sedimentation, which is thousands of metres deep in some locations, can only be explained by dramatic eustatic variations, or by long term subsidence, or by a combination of both. Conditions favourable to reef growth have been in effect since at least the mid-Miocene, when the Scott Reef/Rowley Shoals platform. Despite the rapid subsidence of the continental shelf edge since the mid-Miocene, associated with the collision of the Australian and Asian blocks, Seringapatam, Scott Reef and the Rowley Shoals persist as a disjunct line of reefs rising from the continental slope beyond the 200 m bathymetric contour. In the north-eastern sector, shoals form an extensive but largely inactive complex, grading in some instances to active submerged reefs. This complex of reefs and shoals forms a discontinuous string, reminiscent of the ribbon reefs of the Great Barrier Reef. The present sequence of reef growth would coincide with the post glacial rise in sea levels, stabilised at its present level for about 6000 years. These reefs generally have deep central lagoons, wide reef flats and steep reef-front slopes, and several have developed unvegetated sand cays. Ashmore, Adele and Browse Islands have vegetated sand islands which can be dramatically affected by cyclonic storms.
	Biota:	The flora and fauna of these coral reef systems is typical of oceanic reefs in the Indo-West Pacific region, with some endemism present in the northern sectors. The coral, other invertebrate and fish faunas are species-rich. Seagrass beds are established on the shallower banks and in the lagoons. The islands support sea-bird breeding colonies which in some cases are regionally significant. Marine turtles, cetaceans and Dugong occur generally throughout the region and are also known to breed in this region.
	Estuaries:	Nil
OTW	SA, Vic & Tas/44	Otway
	Climate:	Cool temperate, meso-thermal climate with cool, wet winters and warm, dry summers.
	Oceanography:	Coastline typically high energy, with wave energy dependent on the orientation to prevailing swell direction and cross shelf width. The western region is typified by a high deepwater wave energy, attenuated by a steep offshore–nearshore gradient and offshore reefs which provide for moderate to low energy conditions. Waters are cold temperate and typified by localised, regular, seasonal, cold, nutrient-rich coastal upwellings in the west of the region. Mean sea surface temperatures vary from 14°C in winter to 18°C in summer (decreasing to 11–12°C under the influence of the upwellings). The far eastern region (i.e. King Island area) is influenced during winter months by warm waters, making this region warmer than other Tasmanian waters at that time. Here also, summer water temperatures are cooler than elsewhere in the Bassian Province. Tidal range is microtidal (i.e. ~ 0.8 to 1.2 m range), through much of the area, however tidal ranges and velocities vary rapidly in the that part of the region forming the western entrance to Bass Strait. In the western region, two large unconfined aquifers (in the Gambier Limestone and Dilwyn Formation) discharge freshwater at the coast via beach springs and spring lakes.
	Geology & geomorphology:	Narrow, dominantly south-west facing, continental shelf, including the western entrance to Bass Strait. Small barrier coast dominated by a steeply sloping offshore gradient, dominated by bio-clastic carbonate sediments, and few coastal embayments. Coastal geology comprises headlands of Pliocene–Pleistocene volcanic outcrops, and also Pleistocene dune rock cliffs, shore platforms and offshore reefs (which provide coastal protection), Tertiary sediments and, around King Island, Palaeozoic granite and associated sediments. Sandy beaches common

Region Code	Data Attribute	Description
		in the western region (and around King Island), and also, within coastal embayments (i.e. Rivoli Bay, Guichen Bay) which are characterised by Holocene beach ridge plains, beaches and dunes. Cliffed shorelines common elsewhere.
	Biota:	Marine flora and fauna typically cold temperate (i.e. Maugean element of the Flindersian Province). Intertidal and sublittoral fringe on wave-exposed coasts dominated by the bull kelp, *Durvillea potatorum*. Rocky subtidal macro-algal communities are dominated by *Macrocystus angustifolia, Phyllospora comosa* and other large brown fucoid algae. For many macro-algal communities, this region forms the westward limit of a number of key species. Extensive areas of seagrass occur in the limited sheltered embayments, with smaller areas in the lee of reefs. Subtidal seagrass meadows dominated by *Posidonia australis* in shallow areas, *P. sinuosa, P. angustifolia* and *Amphibolus antarctica* in deeper waters. Rivoli Bay is the easterly limit of *P. coriacea* and *P. denhartogii*. Port MacDonnell is the easterly limit of *P. angustifolia*. Plant species diversity is very high, particularly among the red algae.
		Fish and plant species-richness both high compared to other South Australian, Victorian and Tasmanian regions. This is the only recorded area within Tasmanian waters where several species more typically associated with South Australia occur (e.g. the queen morwong *Nemadactylus valenciennesi*). Coastal wetlands of national importance in the region include Butchers and Salt Lakes, Ewens Ponds, Piccaninnie Ponds and the coastal lakes of Lake Robe, Eliza, George, and St Clair.
	Estuaries:	No true rivers in the western region, but a few groundwater-fed creeks (e.g. Eight Mile Creek, Ellards Creek), and coastal salt lakes intermittently connected to the sea (e.g. Lake George). Six moderate-sized barrier estuaries on King Island and numerous coastal lagoons. See also VES–Victorian Embayments.
PEL	NT/13	Pellew
	Climate:	Monsoonal tropical climate with rainfall of 1000–1200 mm annually. Cyclone frequency is low to moderate. Runoff is low, from 50–125 m of annual rainfall, although a number of rivers with large catchment areas, particularly the Macarthur, Roper and Limmen Bight, discharge in the region.
	Oceanography:	Hydrology is dominated by an internal circulation within the Gulf of Carpentaria which is largely isolated from major oceanic currents. East to west (clockwise) current movement dominates for most of the year, however this may be reversed late in the wet season, particularly during intense north-westerly monsoonal episodes. Inshore waters are often turbid due to fine-grained sediments, strong seasonal winds and shallow waters. Tidal range is meso-tidal (2–3 m variation) while annual sea surface temperature variation is approximately 8–9°C.
	Geology & geomorphology:	Geology is predominantly Precambrian sandstones and siltstones of the Walker and Urapunga Fault Zones and the Wearyan Shelf. Coastal relief is low with extensive areas of intertidal Cainozoic mudflats. Rocky coastal islands occur, with the Sir Edward Pellew Group being the most notable. Sediments consist largely of terrigenous sands and muds.
	Biota:	Mangrove diversity is relatively low (15–26) species dependent on location), with a narrow mangrove fringe in many areas and riverine mangals along major rivers. Coral reefs are sparsely distributed, however extensive seagrass beds are found, particularly along the mainland coast between the Roper and Macarthur Rivers and around the Sir Edward Pellew Group. Northern Territory dugong populations are at their greatest in this region. Sea turtles breed on most of the region's beaches. The Pellew islands support important seabird rookeries, while the mainland coast provides extensive feeding areas for waders and water birds.
	Estuaries:	Three estuary types dominate; straight-banked river mouths (8 of 24 major estuaries); spit-lagoon estuaries (10 of 24 major estuaries); and deltaic river mouths (5 of 24 major estuaries). Major estuaries: Roper, Towns, Limmen Bight, McArthur, Wearyan, Robinson Rivers.

Region Code	Data Attribute	Description
PIN	WA/26	Pilbara (nearshore)
	Climate:	Semi-arid
	Oceanography:	The waters are turbid, especially during periods of spring tides. Tidal range is large with a maximum of 2–6 m. Wave energy is low, but subject to cyclonic storms.
	Geology & geomorphology:	The western part of this sector (west of Cape Preston) lies within the sedimentary Carnarvon Basin with Cainozoic aeolian and beach rock deposits forming the shore. Exmouth Gulf is a major feature at the western end of the sector; its western shore technically belongs to a different geomorphic region, i.e. the Tertiary Cape Range-Rough Range complex, but is included here for convenience. In the east (Cape Preston to Cape Keraudren) the coastline is near the northern margin of the Pilbara Craton constructed of Archaean metamorphic and igneous rocks, although along much of the coast the Archaean rocks are overlain by Cainozoic aeolian and beach rock deposits. The Archaean rocks outcrop on the coast at several places, notably in the Dampier Archipelago and a short stretch of the adjacent mainland. The sea floor is gently sloping and the 10 m bathymetric contour is generally between 1 and 2 n miles offshore. Along the mainland, barrier islands and associated protected lagoons, embayments and deltas predominate and the coast is either open or partly protected by chains and clusters of small, nearshore, shelly limestone or ooid limestone islands (especially in the west). Structurally complex mangals are a feature of the mainland shore, with lesser systems around the islands. Wide supratidal flats occur behind most of the mainland mangals. There is extensive development of intertidal mud flat and sand flat habitats seaward of the mangals. In many areas, especially in the west, there are extensive rock pavements in the shallow subtidal zone, usually covered with a thin sediment sheet. The Dampier Archipelago is an inundated land mass now comprising islands, rocky reefs and shoals rising from a sublittoral plain. The majority of the islands in the Archipelago are of Archaean metasedimentary and igneous rocks, often with Holocene shelly sand plains. Coral reefs are developed around the more distant islands, notably in the Dampier Archipelago. Shelf sediments consist primarily of terrigenous muds but with emergent sand banks and gravelly scour channels in areas of strong tidal flow.
	Biota:	The benthic fauna of this sector is typical of the coastal habitats of the Northern Australian region with the suite of endemic coastal species well represented. Along the Pilbara coast there is a series of discrete mangal systems, some of them more than 50 km long, each with distinctive structural features. The mangals are structurally complex but with fewer mangrove species (5) than those of the Kimberley. This lack of species diversity may relate to the semi-arid climate. There are few places in the world where mangals occur in arid conditions and for this reason they are of great scientific importance. There is no doubt that these mangals contribute significantly to the nutrient resources of the Pilbara coastal waters. The typical suite of common mangal invertebrates is present but there is no information on whether faunistic diversity is comparable to that of Kimberley mangals. The intertidal mud and sand flat burrowing invertebrate fauna is abundant and species-rich which is extremely important as a food source for migratory birds. A feature of the sector is the presence of a diverse benthic invertebrate fauna on rock pavement habitats in the shallow sublittoral zone, consisting principally of sponges

Region Code	Data Attribute	Description
		and scleractinian and soft corals. Seagrasses are also present in the shallows. Although not as extensive as those of the west and south coasts they, along with algal beds, are important elements of the regions ecosystem and support a diverse fauna of herbivorous fishes, turtles and dugong. The shoreward edge of this ecosystem is exposed at extreme low spring tide in many places.
		Scleractinian corals are common even in these turbid inshore waters but, with a few exceptions, coral reefs are developed only around the seaward margins of islands in the outer part of the sector. There is potential for pollution of the waters in the vicinity of the industrial and harbour facilities of Dampier and the western side of Burrup Peninsula and therefore potential for conflict between management objectives of the port-industrial developments and conservation.
	Estuaries:	Several large estuaries, some with extensive mangals and saltmarsh flats, are associated with major seasonal rivers in this region.
PIO	WA/27	**Pilbara (offshore)**
	Climate:	Semidesert tropical.
	Oceanography:	The water is generally clear but may become turbid during periods of spring tide. Tidal range is large with a maximum of 5 m. Wave energy is moderate and subject to cyclonic storms
	Geology & geomorphology:	The area represents the northern margin of the sedimentary Carnarvon Basin. The continental shelf is wide in this vicinity, with a change of slope at about the 20 m bathymetric contour. Just inside this contour there is a series of limestone islands, South and North Muiron, Serrurier, Bessieres, Thevenard, Rosily, Barrow and the Monte Bello Islands. The islands are built of Pleistocene or Tertiary limestone, though usually with Holocene sand cays accreted to them.
		Fringing coral reefs are well developed on the seaward sides of most of these islands. The seaward sides of the Muirons and Barrow have intertidal rock platforms, a habitat not represented in the Pilbara Inshore area. Wide intertidal sand flats occur on the leeward sides of most of the islands, often with the sand forming thin sheets over a rock pavement. Mangals are not well developed. The seabed substrate is mainly terrigenous mud but there is sand and gravel in tidal scours of some areas.
	Biota:	The fringing coral reefs of this sector are extensive and species-rich. The most structurally complex and species-rich coral reefs in the sector occur around the outer islands of the Dampier Archipelago and marine habitats in general are extremely varied. The peculiarities of the Archipelago's geomorphology and biogeographical history, community structure and faunal composition make these reefs unique. Key species of the Indo–West Pacific oceanic coral reef invertebrate assemblages are present. The burrowing invertebrate fauna of the island sand flat habitats is also diverse and abundant. There are small, species-poor mangals and scattered mangrove trees on the lee side of Barrow and in the Monte Bello lagoons but this ecosystem is poorly developed. Many of the Pilbara Islands are important nesting sites for turtles and seabirds.
	Estuaries:	Nil

Region Code	Data Attribute	Description
PSS	**Qld/2**	**Pompey-Swains**
	Climate:	No data on rainfall. Between 20 and 25 cyclones/decade.
	Oceanography:	Tidal range between 3 and 5 m.
	Geology & geomorphology:	The area does not lie within a major sedimentary basin, except Capricorn Basin in inner Swains area. Mud fraction in sediments is low, except high adjacent to southern GBR embayment. Sediments are of highly carbonate origin. Many large to medium sized reefs dominate the northern part (Pompey Complex) with many medium to small sized lagoonal and planar reefs in the south (Swain Reefs).
	Biota:	From 60 to just more than 70 genera of hermatypic corals.
	Estuaries:	Nil
RBN	**Qld/7**	**Ribbons**
	Climate:	No data on rainfall. Between 10 and 15 cyclones/decade, lower incidence in the north.
	Oceanography:	Tidal range between 2 and 3 m.
	Geology & geomorphology:	There are no major sedimentary basins in the area. Mud fraction is mostly low except high offshore from Cooktown. Sediments are of highly carbonate origin. Outer fringe of ribbon reefs as far north as Cape Grenville, then small planar reefs. Includes isolated reef complexes, such as Great Detached Reef and Raine Island. Poorly developed reefs behind the fringe, with large karstic banks and submerged platforms. Reef development rates slow.
	Biota:	More than 70 genera of hermatypic corals.
	Estuaries:	Nil
SBY	**WA/31**	**Shark Bay**
	Climate:	Arid to semi-arid but with two major, seasonal rivers entering on the eastern (mainland) side.
	Oceanography:	The water at the open end of the bay is oceanic but there is a marked transition southwards through meta-haline to hyper-saline conditions in the upper reaches of the south-eastern inlets. There is a maximum tidal range of approximately 1.2 m. Wave energy is low to moderate at the open end of the bay, low within the protected inlets.
	Geology & geomorphology:	This is a major, shallow embayment formed by inundation of the coastal plain, protected by a series of off-shore islands built of Pleistocene limestones. The bay is open to the north and has a number of slender internal peninsulas dividing its southern parts into a series of long, north–south aligned inlets. There are many sand banks and sills, the most notable being Faure Sill which bars the entrance to Hamelin Pool. The shores are dominated by wide, carbonate, intertidal flats. The seabed is typically composed of calcareous sands. There is extensive development of seagrass meadows on the shallow banks throughout. There are two major delta formations on the eastern shore (mouths of the Gascoyne and Wooramel Rivers). Sediments are generally carbonate sands.
	Biota:	The features of the Shark Bay marine and terrestrial environments are considered to be of such importance that the whole area is now a World Heritage Area. The dominant habitats of Shark Bay are seagrass meadows, carbonate sand banks and tidal flats. Both marine and terrestrial environments support a diverse fauna. There are 4000 km^2 of seagrass meadows in the Bay, consisting of 12 species, including both

Region Code	Data Attribute	Description
		temperate and tropical species. There is also a species-rich and abundant epiphytic fauna living attached to the seagrasses, and a large variety of fishes and invertebrates associated with them. The carbonate sand banks and flats are almost as extensive. They support an abundant burrowing and epibenthic invertebrate fauna—e.g. 218 species of bivalve molluscs are recorded, the majority being of tropical affinity but with a significant proportion of Southern Australian and West Coast endemic species. The presence in Shark Bay of the world's largest population of dugong is a direct consequence of the vast areas of seagrass meadow on which they feed. Mangal fringes, comprising a single species (*Avicennia marina*), dominate the north-eastern shore south of Carnarvon, with wide supratidal flats behind them. Smaller mangals occur at several central and western localities. The associated mangal invertebrate fauna is depauperate but several tropical species characteristic of this habitat in northern Australia are present, e.g. the mangrove snails *Terebralia palustris* and *Littoria cingulata pristissini,* the latter a locally endemic subspecies of a widely distributed mangrove littorinid. Coral reefs are not developed in the Bay, except for small areas in the channels between the outer islands and in South Passage. These small coral reefs are not species-rich. Noteworthy is the extensive growth of *Turbinaria spp*. A feature of Shark Bay biota is the impact of the salinoclines. The benthic flora and fauna of the hyper-saline inlets, especially Hamelin Pool, are impoverished and there appears to be a gradient between this condition and the species-rich and abundant biota of the oceanic areas closer to the open end of the Bay. The growth of stromatolites in the hyper-saline waters of Hamelin Pool is a feature of international scientific importance in that they are one of only two sites in the world where these life-forms exist in modern sedimentary environments.
	Estuaries:	While there are no true estuaries in Shark Bay there are two large seasonal rivers which form large deltas.
SCT	Qld/1	Shoalwater Coast
	Climate:	Rainfall from 1000 mm to over 1400 mm. Between 10 and 15 cyclones/decade.
	Oceanography:	Tidal range between 4 and 9 m. Greatest range centres on Broad Sound (8 to 9 m).
	Geology & geomorphology:	There are no major sedimentary basins in the region. Mud fraction in sediments is low. Sediment origin is highly carbonate north of Townshend Island, terrigenous to the south. There are no major reefal areas within the region apart from isolated fringing reefs.
	Biota:	The area contains extensive seagrass meadows supporting large populations of green sea turtles and dugong. The fringing coral reefs (although not extensive in carbonate development) contain a large number of temperate species and lack many tropical species unlike reefs found further south. Demersal reef fish stocks are at pristine levels. Twenty mangrove tree species, 25 tree plus understorey species, 8 saltmarsh species. Forms lower closed to open forest communities along sheltered coasts and rivers. Mangrove forests are extensive in spatial coverage and lack human impacts. From 60 to 70 genera of hermatypic corals.
	Estuaries:	TBA

Region Code	Data Attribute	Description
SGF	SA/41	Spencer Gulf
	Climate:	Semi-arid or `Mediterranean' climate, with hot, dry summers and cool, moist winters.
	Oceanography:	Semi-confined inverse estuary, with minimal freshwater water input and higher salinities and temperatures in the upper reaches of the Gulf. Waters are transitional warm to cold temperate, with mean sea surface temperatures varying from 13°C in winter to 18°C in summer, at the entrance of the Gulf. Low to moderate wave energy coastline. Tidal range, microtidal ~ 1.8 m range. Tides are typified by a regular period of minimal tidal movement or `dodge tide'.
	Geology & geomorphology:	Tidal plain coast with shallow offshore gradients, extensive intertidal and supratidal areas, and relatively few sheltered embayments. Coastal geology comprises headlands of Precambrian crystalline rock forming embayments, Cainozoic outwash sediments forming low cliffs and Holocene beaches, dunes, and estuarine deposits.
	Biota:	Marine flora and fauna typical of transitional warm to cold temperate waters (i.e. Flindersian Province). In sheltered areas, intertidal flats are dominated by the grey mangrove, *Avicennia marina*, the brown alga, *Hormosira banksii*, and the seagrasses, *Heterozostera muelleri* and *Zostera tasmanica*. Reef and rocky shore algal communities dominated by *Scaberia agardhii*, *Osmundaria*, *Lobophora* and species of *Sargassum* in low wave energy areas, and species of *Cystophora* (*C. expansa, C. varians*) on moderate energy coasts. Subtidal areas characterised by extensive seagrass meadows, dominated by Posidonia australis in shallow areas, *P. sinuosa, P. angustifolia* and *Amphibolus antarctica* in deeper waters, and small shore fringing macro-algal communities. Plant species diversity low. Distinct SA endemic and subtropical element in the fish fauna (i.e. *Vanacampus vercoi, Filicampus tigris*). Coastal wetlands of national importance in the region include Franklin Harbour.
	Estuaries:	No true rivers, but a few intermittent streams and tidal mangrove creeks (e.g. Franklin Harbour).
SVG	SA/42	St Vincent Gulf
	Climate:	Semi-arid or `Mediterranean' climate, with hot, dry summers and cool, moist winters.
	Oceanography:	Confined inverse estuary, with higher salinities and temperatures in the upper reaches of the Gulf. Waters are transitional warm to cold temperate, with mean sea surface temperatures varying from 12°C in winter to 25.9°C in summer and mean salinities varying from 35.5–42.0%. Low to moderate wave energy coastline. Tidal range, microtidal to meso-tidal ~ 1.2 to 3.3 m range in the upper Gulf areas. Tides are typified by a regular period of minimal tidal movement or `dodge tide'.
	Geology & geomorphology:	Tidal plain coast with a shallow offshore gradient, extensive intertidal and supratidal areas, and few embayments. Coastal geology comprises headlands of Precambrian metasediment and Tertiary cliffs and Holocene beaches, sandflats, dunes, beach ridges, and estuarine deposits.
	Biota:	Marine flora and fauna typically cool temperate (i.e. Flindersian Province). In sheltered areas, extensive intertidal flats are dominated by the grey mangrove, *Avicennia marina*, the brown alga, *Hormosira banksii*, and the seagrasses, *Heterozostera muelleri* and *Zostera tasmanica*. Extensive subtidal seagrass communities occur down to 17 m water depth (becoming sparsely vegetated at greater depths). Subtidal areas characterised by extensive seagrass meadows, dominated by *Posidonia australis* in shallow areas (and northern gulf), *P. sinuosa, P. angustifolia* and *Amphibolus antarctica* in deeper waters (and mid-gulf and sheltered parts of the lower gulf), and small shore fringing macro-algal communities. Seagrasses in the *P. ostenfedii* group form small communities along exposed parts of the lower gulf. Isolated reefs and rocky shore algal communities are dominated by *Scaberia agardhii* and species of *Sargassum* in sheltered areas, and *Ecklonia radiata, Seirococcus axillaris* and species of *Cystophora* in moderately exposed

Region Code	Data Attribute	Description
		areas. Plant species diversity low. Distinct SA endemic and subtropical element in the fish fauna (i.e. *Vanacampus vercoi, Acentronura australe, Campichthys tryoni*). Coastal wetlands of national importance in the region include Clinton, Barker Inlet estuary, Wills Creek, Davenport Creek, Port Gawler, and on Kangaroo Island, American River and Cygnet River.
	Estuaries:	A few true rivers (e.g. Onkaparinga, Port Adelaide, Wakefield Gawler Rivers), and several intermittent streams and tidal mangrove creeks (e.g. American River, Clinton, Wills Creek, Port Gawler).
TMN	NSW & Qld/56	Tweed-Moreton
	Climate:	Subtropical, with hot summers and predominantly summer-autumn rains. Rainfall mostly ranges from around 1400 mm to 2000 mm, but is generally less than 1400 mm north of Fraser Island. There are between 10 and 15 cyclones/decade in the southern Qld section, their incidence being slightly higher to the north of Fraser Island.
	Oceanography:	Coastal oceanographic circulation is dominated by the main stream of the East Australian Current. It produces a longshore southwards flow of tropical Coral Sea waters into temperate NSW continental shelf waters, affecting water temperature, current velocity and direction. Localised centres of upwelling occur (40 day upwelling cycle) during spring time off Evans Head (29°17'S). Their effect on local nutrient levels is significant, with a 5–10 fold increase in normal values observed. The median density of the sea-water in the NSW section is 25.1 with a quartilic range of 0.52. Tidal range is between 1 and 3 m. The wave climate is characterised by a range of typical breaker heights between 1.4 and 3.0 m, and a high relative frequency of peak wave energy occurring in July and a secondary one in February in the NSW section.
	Geology & geomorphology:	The Maryborough and Ipswich sedimentary Basins border most of the coastline in the Qld section, and the Clarence Moreton Basin and New England Fold Belt in the NSW section. The sedimentary mud fraction varies from high within the Moreton Bay and Sandy Straits estuaries to low offshore and north of Fraser island. Sediment origin is mostly terrigenous. There are no major reef structures except for some low diversity fringing reefs within Hervey Bay, and isolated offshore reefs consisting of hard and soft coral on sandstone outcrops, such as Flinders Reef. The continental shelf shows a relatively steep inner shelf (0–40 m), with a flatter mid shelf plain (40–100 m) and a relatively steeper outer shelf (100–130 m). Its width ranges from 25 km (south of 30°) to 50 km (north of 30°) in the NSW section. The inner shelf to 60m consists of well sorted sands, but seawards they become more a poorly sorted mixture of muddy sands, carbonate-rich sands and shelly gravels.
	Biota:	The fauna in the NSW section is characterised by two distinctive species assemblages of temperate reef fishes, echinoderms, and gastropods, and single distinctive species assemblages of hermatypic corals and bivalves. In the Qld section, there are 8 mangrove tree species, 11 tree plus understorey species and 14 saltmarsh species, forming low closed to open forest communities along sheltered coasts and rivers. Narrow saltpans may form at the landward margin. These communities are more diverse north of the Great Sandy Strait and less diverse in NSW. Hard coral diversity varies from less than 50 genera in the south to more than 60 genera of hermatypic corals in the north.
	Estuaries:	The Qld section includes three major passage landscapes, in Southern Moreton Bay (Nerang, Coomera, Pimpama, Albert, Logan and Brisbane Rivers), Pumicestone Passage, and the Great Sandy Strait. Large sand barrier river estuaries dominate in northern NSW.

Region Code	Data Attribute	Description
TST	Qld/9	Torres Strait
	Climate:	Rainfall between 1400 mm and 2000 mm. Between 5 and 10 cyclones/decade.
	Oceanography:	Tidal range between 1 and 3 m.
	Geology & geomorphology:	There are no major sedimentary basins in the region. Mud fraction in sediments mostly low except moderate to high in the north-east. No data on sediment origin. Large planar reefs in shallow water, and medium sized lagoonal and planar reefs to the east.
	Biota:	From 20–27 mangrove tree species, 26–37 tree plus understorey species, 6 saltmarsh species. Forms tall very complex closed forest communities, although stunted or open communities found in marginal areas. More than 70 genera of hermatypic corals.
	Estuaries:	Nil
TWI	NT/16	Tiwi
	Climate:	Wet monsoon tropical climate with annual rainfall from 1400 mm to more than 1800 mm. Runoff ranges from 500–1000 mm of annual rainfall. Major creeks drain almost the entirety of the Tiwi Islands onto the northern coast. Cyclone frequency is low to moderate.
	Oceanography:	Circulation is affected by the Indonesian Throughflow. Currents are generally east to west in the dry season (May to September) and west to east in the wet season (November to March). Sea surface temperatures vary 5°C annually. Tidal amplitude is mesotidal varying from 2 m offshore to 4 m inshore. Waters are generally less turbid than those of the southern shores of the Tiwi Islands. Inshore salinities may be lowered due to wet season runoff.
	Geology & geomorphology:	Geology is dominated by the Cretaceous sediments (sandstones, siltstones, mudstones) of the Bathurst Island Formation. Coastal topography is largely low relief with mangrove lined incised bays separated by low rocky cliffs and some sandy beaches. Sediments primarily consist of terrigenous sands and muds.
	Biota:	Mangrove diversity is average for the Territory coast (29 species), however the mangrove palm Nypa fruticans is relatively abundant. Seagrass beds are common inshore. Dugongs are relatively abundant, while beaches are utilised extensively for sea turtle nesting. Deeper waters (>20 m) are trawled in the Northern Prawn Fishery.
	Estuaries:	Estuary types are dominated by straight-banked river mouths (4 of 16 major estuaries) and spit-lagoon estuaries (8 of 16 major estuaries). Major estuaries: Apsley Strait, Port Hurd, Curtis Haven, Jessie River, Johnston River.
TWO	Vic, Tas & NSW/52	Twofold Shelf
	Climate:	Moist cool temperate with warm summers and a tendency towards winter-spring rainfall.
	Oceanography:	Water temperatures reflect the influence of warmer waters brought into Bass Strait by the East Australian Current, with the southern section of the Twofold Shelf being considerably warmer in summer than other more southerly Tasmanian regions. Along the NSW section coastal oceanographic circulation is influenced mainly by northwards setting coastally trapped waves generated in Tasman Sea waters, although inshore a northerly flowing tongue of Bass Straight water is generally present. The median density of the seawater in this area is 26.43, with a quartilic range of 0.09. Intermittent upwellings occur along parts of the east Gippsland coast. Wave energy is relatively low, particularly in the broader shelf area in the Gippsland

Region Code	Data Attribute	Description
		Basin. Stalled low pressure systems in the Tasman Sea during summer generate higher wave energy at this time. The wave climate in the NSW section is characterised by a range of typical breaker heights between 1.0 and 2.0 m, and a low relative frequency of peak wave energy fluctuations, with a peak of wave energy occurring in February.
	Geology & geomorphology:	The NSW and northern Victorian sections are bordered by the Lachlan Fold Belt and the Victorian coastline is dominated by Quaternary dunes and dune sediments and associated sandy shorelines (mainly Ninety Mile Beach). It also contains numerous occurrences of Palaeozoic sediments and granites. The continental shelf is relatively narrow in the northern section, becoming much broader (and shallower) in the southern area of the Gippsland Basin. Changes in shelf width are associated with marked changes in coastline orientation, from east facing in the north to south-south-east facing in the south. Orientation in the Victorian section varies from south-east to Lakes Entrance, south to Rame Head and then south-east to the NSW border. North of this, the coastline faces generally east-south-east. The continental shelf shows a very steep inshore profile (0–20 m), with a less steep inner (20–60 m) to mid (60–120 m) shelf profile, and a generally flatter outer shelf plain (120–160 m) south-west of Cape Howe. Seaward the sediments are poorly sorted, with a median of 92% sand and 8% gravel; they are composed of organic material, with a median of 64.5% calcium carbonate.
	Biota:	The fauna is characterised by distinctive species assemblages of reef fish, echinoderms, gastropods and bivalves. Reefs are generally dominated by warm temperate species that occur commonly in southern NSW, particularly the large sea urchin *Centrostephanus rodgersii* which removes macroalgae from shallow reefs, creating a coralline algal encrusted habitat.
	Estuaries:	The larger estuaries in this region occur in the south, including the Gippsland Lakes, Sydenham Inlet and Mallacoota inlet. (See also VES–Victorian Embayments.)
VDG	NT/17	Van Dieman Gulf
	Climate:	Climate is monsoon tropical. Rainfall averages between 1200–1400 mm annually. Cyclone frequency is low to moderate. Runoff ranges from 500–1000 m of annual rainfall. Wet season river discharges are high from the Mary, South Alligator and East Alligator River systems. The coastline is relatively sheltered from south-easterly dry season winds, but is exposed to north-west monsoons.
	Oceanography:	Due to physical restriction of gross water movement at the Vernon Islands and Dundas Strait circulation is largely internal. Tidal amplitude is macro tidal, ranging from 4–6 m. Waters are turbid due to fine grained sediments, macro tides, riverine sediment discharges and shallow waters. Sea surface temperatures vary 4–5°C annually. Coastal waters experience periods of lowered salinity during wet season riverine flows.
	Geology & geomorphology:	Geology consists of sediments (sandstones, siltstones) and basement igneous and metamorphic rocks (granite, migmatite, gneiss, schist) of the Pine creek geosyncline overlain in the north-east by Cretaceous sandstones and siltstones of the Bathurst Island Formation. Landforms are dominated by extensive riverine plains fringed at the coast by chenier ridges and saline mudflats. Rocky reefs are scattered infrequently offshore, and a number of small islands occur, particularly in the north-east of the region, with Greenhill Island being the most noteworthy. Sediments are largely terrigenous sands and muds coastally grading to biogenic muds offshore.
	Biota:	Mangrove diversity is high (38 species) in vicinity of the Alligator Rivers. Areas of seagrass provide dugong (Dugong dugon) habitat in the north-east of the region, while flatback turtles (Natator depressus) nest on most of the regions beaches. The coastline exhibits excellent wader and water bird feeding habitat.

Region Code	Data Attribute	Description
	Estuaries:	Estuary types dominated by straight-banked river mouths (6 of 14 major estuaries) and deltaic river mouths (5 of 14 major estuaries). Major estuaries: The Wildman, West Alligator, South Alligator, and East Alligator Rivers, Tommycut, Sampan, Mini-mini and Ilyamari Creeks, and Shamrock Bay.
VES	Vic/59	Victorian Embayments
	Climate:	Moist temperate with warm summers, pronounced west to east variation in catchment run off and seasonality.
	Oceanography:	Because of their small size fetch is limited with the greatest 60 km in Port Phillip Bay There are large changes in tidal phase and amplitude within them compared with the open coast, with a maximum amplitude of 3.1 m recorded in Westernport. Large and rapid changes in tidally induced velocities also occur.
	Geology & geomorphology:	A variety of forms are evident from drowned river valleys to impounded drainage as a result of the development of dune barrier systems. Depositional substrates dominant, with rock outcrops limited mainly to the margins. Tend to be basin shaped, the maximum depth is variable but is generally less than 20 m.
	Biota:	Victorian bays and estuaries contain a diverse range of biotic assemblages depending on their morphological and hydrological characteristics. Port Phillip Bay is a marine embayment fringed by seagrass beds, rocky reefs and sandy beaches. The benthic assemblages in the muddy central region are distinct from those in the sand to the west and east. Western Port Bay and Corner Inlet are large muddy estuaries with extensive mudflats and seagrass beds. The turbid water in Western Port allows many subtidal animals to occur in relatively shallow water. The small narrow estuaries in western Victoria have an impoverished benthic fauna compared to those in the east which tend to be larger and better wind-mixed. The dominant seagrass species are Zostera muelleri and Heterozostera tasmanica, with large areas of *Posidonia australis* occurring in Corner Inlet/Nooramunga, and the east coast species *Zostera capricorni* reaching its southern limit in Mallacoota Inlet. The estuaries of eastern Victoria are distinguished from those in the centre and west by the presence of penaid prawns.
	Estuaries:	Various
WCY	Qld/10	West Cape York
	Climate:	Rainfall from less than 1000 mm in the south to over 1400 mm in the north. Between 10 and 15 cyclones/decade, higher in Weipa area.
	Oceanography:	Tidal range between 3 and 4 m.
	Geology & geomorphology:	The Carpentaria sedimentary basin lies within the region. Mud fraction mostly low except in Albatross Bay and adjacent to the mouths of major coastal streams. There are no major reef structures in the region.
	Biota:	Twelve mangrove tree species, 17 tree plus understorey species, 10 saltmarsh species. Forms a dense coastal or riverine fringe, backed by wide (20 km or more) saltpans. More than 70 genera of hermatypic corals.
	Estuaries:	Several major river systems, including Archer and Wenlock. Rivers meander through coastal floodplains and retain sufficient freshwater inflow in the dry season to avoid hypersalinity.

Region Code	Data Attribute	Description
WLY	Qld/35	Wellesley
	Climate:	Monsoon tropical. Rainfall less than 1000 mm. Between 5 and 10 cyclones/decade.
	Oceanography:	Tidal range between 3 and 4 m, predominantly diurnal. Wellesleys interrupt the generalised clockwise circulation of the Gulf, pushing the coastal boundary layer further offshore. More influenced by terrestrial inputs that the circulating Gulf water mass.
	Geology & geomorphology:	The region lies within the Carpentaria sedimentary basin. Mud fraction is low around the Wellesley Islands to moderate along the mainland shore. Sediments are of terrigenous origin. Fringing reefs only in the northern part of the Wellesley group. The mainland coast is comprised of eroding sandy-mud intertidal flats.
	Biota:	Significant dugong, turtle and seabird habitat on islands and adjacent seagrass beds. Structurally significant coral reefs especially on the northern side of Mornington Island, however no data on species-richness.
	Estuaries:	No major estuaries. Streams mostly short coastal saltwater creeks.
WSC	WA/36	WA South Coast
	Climate:	Temperate with a moderate to high rainfall in the west, mostly in winter, decreasing to semi-arid in the east.
	Oceanography:	Water is clear. Swept by the West Wind Drift. Tidal range is a maximum of 1 m and it is a high energy coast with the headlands exposed to heavy swell.
	Geology & geomorphology:	The southern margin of the Yilgarn Craton is fringed by a zone of intense Proterozoic tectonic activity and is characterised by granites and high-grade gneisses forming prominent headlands. Between the headlands there are arcuate bays with beaches backed by Holocene dune fields. Superficial Pleistocene aeolian limestone is commonly deposited along the south-western sides of the headlands. There are many semi-sheltered bays and a few (notably King George Sound) that provide good shelter. Consequently, coastal habitats are highly varied. Estuarine habitats are a feature of the sector, with large and small estuaries of the riverine and basin types, and a range of salinity regimes relating to whether they are seasonally open or closed. [Note: within this zone there is another coastal type, formed by outcropping of the Eocene sediments of the Bremer Basin. It forms a distinctive coastal type but there are only a few, small examples of it.]
	Biota:	The affinities of the coastal marine and estuarine flora and fauna lie strongly with the Southern Australian region but with a significant local endemic element (the south-west endemic species). There are a few Indo–West Pacific stragglers. Extensive seagrass meadows are a feature of sheltered bays and inlets. Kelps dominate rocky substrates in the sublittoral zone. There is a rich rocky shore intertidal fauna. The estuarine floras and faunas are depauperate due to the marked seasonality of the estuaries. Many nearshore islands are haul-out and breeding sites for Australian sea lions and New Zealand fur seals. Southern right whales make extensive use of sheltered bays.
	Estuaries:	There are many rivers, some with major estuary development. Eastern estuaries are fed by saline rivers. The Western estuaries are of two types, riverine and lagoonal. They may be further classified as 'permanently open' and semi-permanently closed' and in this respect the Hardy, Nornalup-Walpole and Oyster Harbour are of the former type and the remainder the latter. In terms of conservation value, Wilson Inlet and Nornalup-Walpole are of particular significance. Wilson Inlet supports the largest recreational and commercial estuarine fisheries on the south coast of Western Australia and it's size, and extent and diversity of it's associated wetlands suggest that it contributes significantly to the ecology of the local area. Nornalup-Walpole Inlet is the only estuary on the south coast whose catchment is composed of forested National Park and has invertebrate fauna second only in diversity to Oyster Harbour. Oyster Harbour and Princess Royal Harbour are important recreational fishing grounds and are subject to pressure from the proximity of the city of Albany.

Region Code	Data Attribute	Description
WTC	Qld/6	Wet Tropic Coast
	Climate:	Rainfall from 2000 mm to more than 4000 mm in the Innisfail-Tully area. Approximately 15 cyclones/decade, slightly higher in Cairns area, lower towards Hinchinbrook and Cooktown.
	Oceanography:	Tidal range between 2 and 3 m.
	Geology & geomorphology:	There are no major sedimentary basins in the region. Mud fraction in sediments is high on coast to moderate just offshore. Sediments are of terrigenous origin. Poorly developed inner shelf reefs adjacent to Cooktown. No data on fringing reef types.
	Biota:	Up to 27 mangrove trees species, 37 tree plus understorey species, 6 saltmarsh species. Forms tall, very complex closed forest communities, although stunted or open communities found in marginal areas. More than 70 genera of hermatypic corals.
	Estuaries:	Several major river systems, fed by very high rainfall in wet season, but retaining significant year round flows. Streams generally short and opening directly to the sea. Very large and complex mangrove dominated wetlands.
ZUY	WA/30	Zuytdorp
	Climate:	Arid to semi-arid with no rivers or streams, except for the Murchison in the south.
	Oceanography:	This is a high energy coast with a tidal range of up to 0.8 m. The water is clear.
	Geology & geomorphology:	Although the shores of the three units of this sector differ in geology, they are all high energy coasts characterised by cliffs and narrow intertidal rock platforms exposed to heavy swell. i) The mainland coast between Gnaraloo Bay and Quobba is formed of cliffs in Miocene (in the north) or Pleistocene (in the south) limestones, with a low, undulating hinterland. The northern cliffs are high and fronted by narrow intertidal rock platforms. The cliffs are lower and the rock platforms wider in the south. ii) The seaward shores of Bernier, Dorre and Dirk Hartog Islands, the Edel Land Peninsula and south almost to Kalbarri are high cliffs in Pleistocene limestone with steep scree slopes and narrow intertidal rock platforms exposed to heavy swells. The cliffs are backed by extensive dune fields. iii) The short stretch of coast south of Kalbarri (mouth of the Murchison River) consists of high cliffs in flat-bedded Mesozoic sandstones fronted by narrow intertidal rock platforms exposed to heavy swells. The hinterland is low and undulating. The continental shelf is wide in this sector. The coastal sediments are calcareous.
	Biota:	The sector has been little studied. The sparse information available suggests that the rocky shore intertidal faunas comprise a mixture of tropical (Indo–West Pacific), West Coast endemic and temperate (Southern Australian) species. Nearshore sublittoral rocky reefs are covered with algae but these communities are unstudied.
	Estuaries:	The Murchison Estuary is of the riverine type and is permanently open to the sea although there is an entrance bar.

Appendix 6: Biophysical Descriptions of the proposed IMCRA provinces for the External Territories (see Map 4)

Code	Data Attribute	Description
AAP		Australian Antarctic Province
	Climate:	High cloudiness throughout the year, very low absolute humidity, and low precipitation. Temperatures vary from around –30°C in winter to +10°C at noon in summer. Frequent intense low pressure systems moving from west to east, with gale to hurricane force south-easterly winds.
	Oceanography:	Southern Ocean–tides of 1–1.5 m; sea temperature between –1.2°C and +2°C; wave energy dampened by sea-ice, ice bergs, and prevailing off-shore winds. From May to December/January the sea is frozen, typically up to 2 m thick and extending up to 150 n miles from the coast.
	Geology & geomorphology:	TBA (Less than 1% of the coast of the AAT is ice free.)
	Biota:	Superabundant seabirds and seals; low species diversity.
	Estuaries:	None in the conventional sense. Numerous glaciers and ice shelves terminate at the coast, and indeed form most of it. Short term but extensive summer coastal melt streams discharge direct from the ice to the sea–and from the <1% of the coast which is ice-free but mostly nutrient deficient.
SunP (a)		Sunda Province (a) Christmas Island
	Climate:	Tropical, equatorial climate with a wet season (December–April) and a dry season. Mean annual rainfall is 1930 mm. No cyclones recorded passing directly over the island but strong winds and rain from cyclones affect the area during the wet. Humidity is in the range 80–90 %. Average daily maximum temperature is 28°C in April and the average daily minimum temperature falls to 22°C in August.
	Oceanography:	The dozen small beaches around the island are exposed only at low tide. The average tidal fluctuation is about 0.5-1.0 m. Surrounding waters are remarkably clear.
	Geology & geomorphology:	The island is believed to have formed from a volcano that subsided and later re-emerged in a series of uplifts, giving it a stepped appearance. Each terrace formed by the combined effects of fringing reef development and erosion of the sea cliff. The coastline is predominantly sheer rocky cliffs (10–20 m), with a few small sand and coral rubble beaches. Shoreline platforms occur slightly above sea level around the Island. At low tide on these platforms, many pools are maintained by wave splashes. The waters surrounding the island include sand flats, caves, coral reefs and coral heads or 'bommies'. Active coral formations occur to depths down to 50m.
	Biota:	Eight species or subspecies of seabirds nest on the Island, two are endemic. The red-footed booby is the most widespread seabird. Others include: brown booby, Abbott's booby (endangered), Christmas Island frigatebird, greater frigatebird common noddy, silver bosun (tropic bird) and golden bosun. Dolphins and whales are seen around the Island. Small numbers of green and hawksbill turtles nest on some beaches, and sea-snakes (although extremely rare), including *Pelamis platurus*, also occur.

Code	Data Attribute	Description
		Sixty-eight percent of the islands 575 fish species are widespread in the Pacific and Indian Oceans. The fish fauna is more closely allied to the West Pacific province of the Indo-West Pacific faunal region than to the East Indian Ocean region. Only one endemicspecies, *Centropyge joculator*, shared between Christmas Island and the Cocos (Keeling) Islands.
		A total of 88 reef-building corals were identified in 1988 and coral species diversity is considered low. Gorgonians and antipatharians (black corals) are found on deeper reef slopes.
		Other fauna include: numerous sponges, 313 sponge species, 87 echinoderm species, and 204 decapod crustacean species.
	Estuaries:	There are no estuaries on Christmas Island, but a few perennial streams, arising at the interface of limestone and basalt, reach the sea above sea-level, while some underground aquifiers emerge below sea-level.
SunP (b)		Sunda Province (b) Cocos (Keeling) Islands
	Climate:	The climate is humid and tropical, characterised by north-west monsoons from January to May, and relatively strong south-east trade winds outside of the monsoon season. Cyclones occur frequently in the area. Average daily maximum temperature is 28.9°C and average daily minimum is 24.4°C. Mean annual rainfall is about 2000 mm.
	Oceanography:	The Islands experience about a 1.2 m tide. At low tide, beaches approximately 5–15 m wide are exposed around the islands. The South Equatorial Current circulates anti-clockwise around the islands. Occasional wind-driven currents bring surface water and associated flotsam from the Java-Indonesia region.
	Geology & geomorphology:	Twenty-seven coral islands form two atolls; North Keeling is a single, uninhabited atoll 24 km to the north. The atolls have developed on top of old volcanic seamounts, rising from a depth of 5000 m in the north-eastern Indian Ocean. The two atolls are located on two of a series of undersea features known as the Vening Meinesz Seamounts.
		All the islands have steeper sand or shingle beaches to seaward and gentler sloping sand or muddy shorelines on the lagoon face. North Keeling is almost continuous around the perimeter of a shallow lagoon which drains almost completely at low tide. A reef crest surrounds the majority of the island, except the north-west corner. A highly mobile broad sandy beach, rising 4 m above sea level occurs on the northern shore of the island becoming more coarse with shingle to the west.
	Biota:	The atolls represent the western limit for many species of the western Pacific. The isolation of the islands is thought to influence their faunal composition. The fauna is relatively depauperate compared with other atolls.
		Eleven seabirds use the North Keeling atoll for nesting. It is one of the few significant rookeries left in the world for the red-footed booby (*Sula sula*). Other species include white tern (*Gygis alba*), sooty tern (*Sterna fuscata*), masked booby (*Sula dactylatra*), brown booby (*Sula leucogaster*), least frigatebird (*Fregata ariel*), great frigatebird (*Fregata minor*), common noddy (*Anous stolidus*), red-tailed tropic bird (*Phaethon rubricauda*) and white-tailed tropic bird (*Phaethon lepturus*).
		Nesting of the green turtle (*Chelonia mydas*) and the hawksbill turtle (*Eretmochelys imbricata*) has been reported. The green turtle is confined largely to the north-western and southern beaches of North Keeling. Some 525 fish species are recorded from the Cocos islands, of which 175 are lagoon species. One species, the angelfish (*Centropyge joculator*), has only been recorded from these islands and Christmas Island.

Code	Data Attribute	Description
		Ninety-nine species of reef-building corals are recorded from the atolls; all but twelve of these are recorded from WA. Nine species are not recorded elsewhere in the eastern Indian Ocean and two may be endemic. About 528 fish species have been recorded; most have distributions that cover large areas of the Indo-Pacific region. The mollusc fauna is diverse (610 species recorded) and includes: 496 gastropods, 109 bivalves, 1 chiton and 4 cephalopods. Close to 200 species of decapod crustaceans and 89 echinoderm species are recorded. Numerous patches of seagrass occur within the lagoon of North Keeling Island.
	Estuaries:	Nil
KergP		**Kerguelen Province**
	Climate:	TBA
	Oceanography:	Kerguelen Plateau is one of a number of major geographic features deflecting the path of the Antarctic Circumpolar Current. It is one of two locations (the other is Drake Passage) which allows the northward flow of Antarctic Bottom Water away from the Antarctic continent. Inter-annual variability has important implications for global climate variability. While most of the Antarctic Circumpolar Current is directed north of Isles Kerguelen, it appears that a significant portion of the variability is in the part of the current flowing past Heard Island. For these reasons, Heard Island is an important site for studying inter-annual variability of the Southern Ocean. This variability can be monitored indirectly by monitoring sea level variability with tide gauges. The deployment of a long-term high-resolution coastal tide gauge at Heard Island, geodetically controlled with GPS, will provide important information on inter-annual variability of the Antarctic Circumpolar Current and ultimately on climate variability. The oceanographic conditions surrounding Heard Island strongly influence the distribution of biological species and productivity in the water column. More detailed studies will be required of these oceanographic issues if the biological parameters are to be well understood.
	Geology & geomorphology:	Heard Island and the McDonald Islands, together with the Kerguelen Islands, represent the only surface evidence of the otherwise extensive submarine Kerguelen Plateau, which is an unusual platform for oceanic islands. The Island's geological history therefore contributes greatly to the understanding of the development of submarine plateaus. Sediments exposed on Heard Island contain a valuable record of past environments on the oceanic platform. This includes evidence of warmer sea-surface temperatures and of terrestrial vegetation, including trees, significantly different from that of today. Big Ben, which is Australia's only active volcano, presents special opportunities for vulcanological studies because of its unusual lava association and setting on a large submarine plateau. There is a potential for telemetering of volcanic eruptive activity, volume and variations in head flow. Recent evidence has confirmed that a large part of Big Ben has slumped to the south-west, creating an arcuate escarpment and leaving a cavity that the modern volcano has done much to fill. This suggests that Big Ben is more dynamic than previously believed. Heard Island has Australia's only permanently glaciated environment outside the Australian Antarctic Territory and affords opportunities for studies of highly dynamic glacial systems. The recorded glacial fluctuations on Heard Island provide a useful indicator of climate or volcanically-induced changes in this part of the Southern Ocean, for which there are few instrumental records. The rapid fluctuation provides an opportunity to use glacier advance and retreat as an indicator of short-term trends.
	Biota:	The seal populations provide outstanding opportunities to establish indicators for the health and stability of the larger Southern Ocean ecosystem. The Antarctic fur seal and the elephant seal populations are recolonising the area. Heard Island is one of the best land-based sites in the world to study the leopard seal and its role in the subantarctic ecosystems.

Code	Data Attribute	Description
		The Territory is a key subantarctic breeding location whose bird fauna, like that of other subantarctic islands, is characterised by superabundant numbers and low species diversity. The high degree of nest fidelity exhibited by the bird species is believed to have contributed to endemism in the region. The bird fauna therefore provides excellent opportunities to study species diversity and endemism, population dynamics and colonisation behaviour of subantarctic birds. The absence of introduced predators of burrowing petrels and sheathbills makes the Territory an especially valuable location for observing these birds. The Territory is also the home of the endemic and rare (less than 100 breeding pairs) Heard Island cormorant.
	Estuaries:	
MacP		Macquarie Province
	Climate:	Subantarctic wet and windy climate with extremely uniform mean air temperatures varying from 3°C in winter to 7°C in summer. Mean annual rainfall of 895 mm which occurs as mist, rain and snow throughout the year.
	Oceanography:	Located just north of the Antarctic Convergence in an oceanic region strongly affected by West Wind Drift. Sea surface temperatures vary from 3.3°C to 7.3°C. Microtidal (ca. 1 m range) with mean wave height on west coast of ca. 1 m and ca. 0.6 m on east coast.
	Geology & geomorphology:	Macquarie and associated islands represent an extremely isolated fragment of mid-oceanic ridge (Macquarie Rise) uplifted above sea level in the Miocene. The eastern coast of Macquarie Island is relatively straight with few bays while the western coast has numerous indented bays, shingle beaches and raised marine terraces.
	Biota:	Possesses a distinctive subantarctic flora and fauna with a high proportion of endemic algal and invertebrate species. The deep-water fauna is closely allied biogeographically to the fauna of the New Zealand subantarctic islands and has probably migrated to the island along the Macquarie Ridge. Strongest shallow-water biogeographic affinities are with the Kerguelen and Crozet regions of the southern Indian Ocean, from which numerous plants and animals probably arrived via the West Wind Drift.
	Estuaries:	Nil
NorfP (a)		Norfolk Province (a) Norfolk Island
	Climate:	Norfolk Island has a pleasant maritime climate, with small diurnal and annual temperature ranges (both 6°C, with an absolute minimum of 4.3° and an absolute maximum of 35.9°), and high humidity. Rainfall is greatest during the four months from May to August with monthly averages of about 140 to 150 mm. The mean annual rainfall is 1326 mm. The mean annual evaporation is approximately 1600 mm. The average relative humidity is moderately high with no seasonal pattern. The average monthly humidity varies between 76–81% at 9 a.m. and 72–76% at 3 p.m. The monthly average hours of sunshine per day vary from 8.1 hours in November to 5.1 hours in June. The predominant wind direction is easterly for the summer months, turning to westerly during winter. From 1939–1989 there were 77 days when gales of 34 knots or over were recorded and over 500 days of strong winds between 22 and 33 knots. February and March are the windiest months and August to November the calmest. Thunderstorms are most prevalent during the winter and spring. Tropical cyclones approach from the north on a track generally directed south-eastwards between November and April.

Code	Data Attribute	Description
	Oceanography:	Moderate seas are a feature of all seasons at Norfolk Island, tending to slight during the summer months. Rough to high seas accompany cyclonic disturbances and those periods of strong south-westerly winds. Norfolk Island is affected by the warm currents from New Caledonia which flow from October through to May each year. These bring the food organisms which are followed by the larger migratory species such as whales, and also the seabirds, whose breeding success is also dependent on plentiful supplies of these food organisms.
	Geology & geomorphology:	Norfolk, Nepean and Phillip Islands are a group of small volcanic islands superimposed on the extensive submarine Norfolk Ridge, which extends from New Zealand to New Caledonia. While the time period for the break-up of the Australian-Antarctic Plate and associated movement of the various plates is dated as 80 to 65 million years ago (late Cretaceous to Early Tertiary age) the sediments forming the Norfolk Ridge may be much older. Formation of the Norfolk Ridge, produced by tensional movements, may well have been helped by intrusions of magma and faulting. Marine sediments would have blanketed the terrestrial sediments. It has been suggested that a dispersed island chain linked New Zealand and New Caledonia. An age of 20 million years has been determined from limestone fragments found in Phillip Island tuffs. The earliest observable volcanic event was the eruption of basaltic lavas from an unknown vent. These lavas have been named the Ball Bay Basalt and are dated as having formed 3 million years ago. This stage of eruption was brief, lasting about 100,000 years, followed by a quiet period of some 200,000 years. The ages of the rocks of Phillip Island span an interval of about 170,000 years (that is, they are 2.79–2.62 million years old). While much conjecture surrounds changes in sea level in late Cainozoic times (23 million years to present), it would appear that variations did not exceed more than a few tens of metres (around 40 m) during the later development of the Norfolk Ridge. Certainly some variation in sea level would help to explain the presence of the carbonate 'sands' (calcarenite) up to 40 m thick forming Nepean Island. These sands are dated at 22,000 years old. They include the fragmented remains of shells and corals, but are primarily of algal origin.
	Biota:	Norfolk Island is one of only three subtropical island groups in the south-west Pacific Ocean (together with Lord Howe Island and the Kermadecs). Species diversity of tropical and temperate species of fishes, corals and other marine organisms declines across these island groups from west to east. A total of 231 species of marine algae have been recorded. Some local species are at the northernmost limits of their distributions. Opisthobranch species number 160 in Norfolk's coastal waters; 41 are new species and 25 considered endemics. The other mollusc groups (chitons, limpets, pulmonates, gastropods, bivalves, nautilus, spirula, octopus, argonauts) comprise at least 240 species including 18 endemics. The echinoderms of the region have not been studied in detail. World-wide there are few isolated oceanic islands at similar latitudes to Norfolk Island and there are few coral reefs further than this from the equator. Kingston lagoon contains a unique and diverse sub-tropical coral fauna, which includes at least 32 species of reef-building corals from 11 of the 16 coral families. The Norfolk Island coral assemblage is closely related to that at Lord Howe Island. At these latitudes there is significant competition for space between corals and seaweeds (marine algae). The balance appears to be maintained by algal grazers, the most significant of which are (nocturnally foraging) sea-urchins and some fish species of the families Scaridae, Acanthuridae and Siganidae. Coral cover and diversity increase dramatically within 50 m of the stream outflow at Kingston. Upwellings of colder, nutrient rich waters also affect coral reefs near the edges of continental shelves.

Code	Data Attribute	Description
		Most of Norfolk Island's fish species are also found at Lord Howe Island and/or the Kermadec Islands (Lord Howe has over 400 coastal fishes, Norfolk about 250 and the Kermadecs 120). Two very common fish species are, however, endemic to Norfolk–a bigeye cardinalfish *Archamia leai* and a blenny *Parablennius serratolineatus*. Both species are found in large numbers around coral bommies and vertical reef faces.
		Large sharks, including white pointers, have been seen and caught in Norfolk waters.
		The Norfolk Ridge sea-bass (*Caprodon longimanus*) fishery declined dramatically (to one sixth of the original stock) after exploratory trawling in 100–200 m for 47 days during 1976. Other species recorded in this trawling survey were *Squalus blainvillei, Glossanodon sp., Centroberyx affinis, Zenion sp., Nemadactylus macropterus* and *Allomycterus pilatus*.
		Green turtles *Chelonia mydas* are present in Norfolk Island waters but their movements have never been studied closely. Green turtles are commonly sighted around Norfolk Island but they do not nest on the Island. The sand temperatures on Norfolk Island do not appear to be in the range for the development of turtle eggs.
		The migratory species which may be seen include humpback, killer and right whales. Smaller dolphins are often seen in the waters around Norfolk Island but it is not known if they are present all year round. Other sightings in the area include sei fin, pilot and sperm whales. Since the whaling industry ceased to operate in 1962, increasing numbers of whales can be observed passing Norfolk Island, predominantly humpback whales.
		Seals have been recorded as vagrant visitors to Norfolk Island's waters, but only rarely, and reports of their sightings are sketchy. The most interesting marine mammal sightings are of what might be the, so far uncollected Longman's beaked whale, *Mesoplodon pacificus*, in the waters east of the Island.
		The following seabirds breed on Phillip Island: black-winged petrel, *Pterodroma nigripennis;* Kermadec petrel, *Pterodroma neglecta;* providence petrel, *Pterodroma solandri;* wedge-tailed shearwater, *Puffinus pacificus;* little shearwater, *Puffinus assimilis assimilis;* Australasian gannet, *Morus serrator;* masked booby, *Sula dactylatra personata;* red-tailed tropic bird, *Phaethon rubricauda roseotincta*; sooty tern, *Sterna fuscata serrata*; common noddy, *Anous stolidus pileatus;* Black Noddy, *Anous minutus minutus*; and grey ternlet (Patro or little blue petrel), *Procelsterna albivittata albivittata*. Norfolk Island is also a stop-over point for many migratory waders and rare sightings of penguins have been recorded.
	Estuaries:	Nil
NorfP (b)		**Norfolk Province (b) Lord Howe Island**
	Climate:	Average air temperature ranges from around 13.5°C in July–August to 25°C in February. Winds are variable throughout the year, with easterly's predominating in summer and south-westerly's in winter. Cyclones are not common. Average annual rainfall is 1686 mm, with a winter maximum of 188 mm in July and a summer minimum of 106 mm in February. Average number of rain days is 190 (with a maximum of 22 in July and a minimum of 11 in February). Cloud cover (primarily orographic) is generally high.
	Oceanography:	Tidal range is comparable to that on the Australian south-east coast (i.e. ~ 2 m), with a lag of around 30 minutes behind Fort Denison (Sydney Harbour). Local tidal currents are variable, with the passages entering the fringing coral lagoon displaying strong tidal ebbs and flows. Eddies from the strongly southward-flowing East Australian Current bathe the Island, especially in the summer, and are responsible for a large part of the recruitment of tropical organisms to this area from the Great Barrier Reef. At other times cool temperate southern waters may predominate.

Code	Data Attribute	Description
		The wave climate is variable, with large oceanic swells resulting from the passage of low pressure systems. Summer water temperature averages around 23°C, and winter around 18–19°C. Lagoon temperatures can be up to a few degrees warmer.
	Geology & geomorphology:	Lord Howe Island is located some 630 km off the north coast of New South Wales to the east of Port Macquarie at around 31.5° South latitude. The Island is of volcanic origin and consists of a narrow strip of land extending for about 11 km in a general north-south direction. The most conspicuous topographical features are the twin peaks of Mt Lidgbird (765 m) and Mt Gower (866 m), which occupy much of the southern portion of the island and rise abruptly from the sea. They form a spectacular backdrop to the lagoon, which is situated on the leeward or western side of the island. The lagoon is approximately 6 km in length and 1 kilometre across at its widest point. It is mostly shallow (average depth about 1 m) and consists largely of sandy bottom, but in several areas depths to 8 m, rich with living coral, are encountered. The lagoon barrier reef is pierced by several passages, the northern-most constituting the main entrance to the lagoon, with depths of 4 to 6 m. Outside the lagoon the shoreline drops off steeply to depths of 15 to 20 m and then gradually slopes to deeper water. The 200 m depth contour is generally located 7 to 12 km offshore. There are several small rocky islets around the periphery of Lord Howe Island. The most noteworthy are in the Admiralty Group, which comprises 7 islets, the closest of which is situated 1.5 km off the north-eastern tip of Lord Howe Island. Ball's Pyramid is a monolithic spire which rises to an elevation of 549 m and is located about 30 km south-west of the main island. Geologically unrelated to the rest of the Australian continent, Lord Howe Island is located on the top of a large wave-cut platform that measures about 24 km by 32 km. This platform is part of a much larger geological structure known as the Lord Howe Rise, which resulted from the Cretaceous split of the Tasman and New Caledonian Basins. Most of the Island (and all of Ball's Pyramid) is composed of igneous rocks (including breccias and tuffs), the oldest series of which are late Miocene in age (about 10 million years old). The northern part of the Island, and the Admiralty Islets, are cut by numerous dykes which, subtidally, have been eroded away to form deep (up to 5 m) rifts in the surrounding rock. Deposits of calcarenite are to be found in the central section of the Island. These rocks are composed of grains of calcium carbonate of biological origin cemented together in a matrix of calcareous cement. Sedimentary deposits are generally young, the oldest being of Pleistocene age (about 2 million years old). Sand grains are typically composed of calcareous material and arise from either the weathering of calcarenite or from calcareous fauna and/or flora. Even in the protected confines of the lagoon the grain sizes are relatively large. The finest sediments are only found in the deeper holes. The coral reef associated with Lord Howe Island and, in particular, the coral lagoon, are of Recent age. Little is known of the geological history of the reefs and whether they are currently static, expanding or contracting.
	Biota:	Most of the algae in Island waters belong to tropical and subtropical genera such as *Padina* and *Dictyota*. Growth is very lush compared with the Great Barrier Reef, and this may be due to the relative scarcity of herbivorous fish. Around 40 species of green algae, 32 species of brown algae (22 of the Order Dictyotales), and 163 species of red algae had been recorded from the Lord Howe Island area by 1981. There was a high degree of endemism displayed, with 3 species of green algae, 6 species of brown algae and 19 species of red algae being classified as endemic.

Code	Data Attribute	Description
		The seagrasses *Zostera* and *Halophila* occur in patches over the entire length of the lagoon. In some places *Zostera* is dominant and in others *Halophila*. Stands on steep sided mesa-like hummocks indicate that seagrasses may play a role in stabilising the lagoon floor. Mangroves are only found in very restricted localities on the Island and comprise the most restricted plant community. There were two stands of the river mangrove *Aegiceras corniculatum* on the Island in 1985. Lord Howe Island supports the southernmost lagoonal fringing coral-reef in the world, and provides one of the few known examples of a transitional coral-algal reef. Reef building corals are common but usually exist as scattered isolated colonies and not as massive reefs (as they do on the Great Barrier Reef). Coral growth is profuse only in very restricted areas around the edges of the deeper lagoon holes. At least 65 species of corals, belonging to around 35 genera, have been recorded from Island waters. At least 65 species of echinoderms (around 70% tropical, 24% temperate, and 6% endemic forms) and at least 120 species of molluscs (including 26 land snails) have been recorded. Numerous anemones, hydrozoans and crustaceans, as well as many representatives of other common marine invertebrate groups, have also been recorded from Island waters. The known fish fauna comprised at least 447 species from 107 families in 1976. The inshore fish fauna is a combination of tropical and temperate forms. Of the 390 species of inshore fishes, 60% were wide-ranging tropical forms, 10% were found only in Lord Howe Island, Southern Australian and/or New Zealand waters, less than 4% were endemic to the Lord Howe region, and 32% were restricted to the South-Western or South Pacific Oceans. Despite the low degree of endemism, endemic fishes are still among some of the most abundant shore fishes (as with the fish fauna of the Hawaiian Islands and Easter Island). This high abundance of endemics could be caused by either successful adaptation over a long period or the Island's subtropical location attracting both temperate and tropical derivatives. Turtles (probably mainly green turtles) are reputedly common in summer, but rarely seen in winter. Lord Howe Island is also famous for its extinct horned turtle *Meiolania*. A wide variety of seabirds inhabit and feed around Lord Howe Island, and a number breed on it. Important species include: providence petrel (only known breeding locality); Kermadec petrel (only known breeding location in the Australian region); fleshy-footed shearwater (only breeding locality in eastern Australia); masked booby (most southerly breeding colony in the world); red-tailed tropic bird (greatest nesting concentration in the world); sooty tern (one of the most southerly breeding stations known); noddy (one of the most southerly breeding stations known); and grey ternlet (only known breeding location in Australia). A number of species of whales and dolphins are commonly sighted in Island waters, though no documentation on these could be found.
	Estuaries:	There are three small 'estuarine' habitats entering the lagoon on the western side of the island, only one of which is regularly flushed by the tides. Overall, there is very little fluvial input to the marine environment, except after very heavy rains.

Code	Data Attribute	Description
NorfP (c)		**Norfolk Province (c) Elizabeth and Middleton Reefs**
Climate:		No weather information is available for this immediate area. Data for Lord Howe Island (150 km south) indicate that average air temperatures range from around 13.5–25.0°C. Wind direction is variable, depending on the season.
	Oceanography:	Local surface currents are poorly understood. At the regional level, however, the reefs lie in an area that receives water from both the warm tropics and the cool temperate Southern Ocean. The East Australian Current brings warmer tropical water southwards along the east coast of Australia and then swings eastward. The tidal range at Middleton Reef is 0–2.6 m.
	Geology & geomorphology:	Elizabeth and Middleton Reefs are volcanic seamounts rising steeply from the Lord Howe Rise. The two reefs are similar in most respects, including size (approx. 8 x 6 km). Volcanic activity is thought to have occurred from Eocene to Miocene times, but the volcanoes formed were not as large as those at Lord Howe Island. Both Elizabeth and Middleton reefs are elongated platform reefs emerging from the tops of volcanic seamounts, i.e. coral atolls. Apart from a small ephemeral sand cay at Elizabeth Reef, the two reefs are entirely submerged at each high tide. Records indicate that the cay was vegetated in the recent past.
	Biota:	Coral diversity is low (122 species) compared to the Great Barrier Reef (550), but much more diverse than at Lord Howe Island (57). Low diversity is attributed to the limited number of reefal habitats. Coral sexual reproduction is synchronised at the two reefs, with a mass spawning event in mid–late summer. A 1987 survey concluded that cover and diversity of live scleractinian corals have become reduced dramatically since a 1981 survey, possibly due to the presence of Crown-of-Thorns starfish. At least 74 species of echinoderms are recorded. More than 500 species of crustaceans are estimated to occur (122 species provisionally recorded). The molluscan fauna (266 species) is overwhelmingly of Indo-West Pacific composition and 3.6% of the species are endemic to the Elizabeth and Middleton Reefs-Lord Howe Island-Norfolk Island region. Scattered individuals of the seagrass *Halophila ovalis* are found in lagoons. More than 500 species of fish are estimated to occur (307 species provisionally recorded). Two-thirds of the fish species have widespread tropical or sub-tropical distributions, the remainder are restricted to the southern or south-western Pacific. Some new species may be endemic to Elizabeth and Middleton Reefs. Populations of the protected but rare Black Cod, *Epinephelus daemelii,* are located on both reefs. Green turtles, *Chelonia mydas*, are relatively common feeding on the reefs but the lack of suitable habitat precludes nesting. Cetaceans common to subtropical South Pacific waters are presumed to occur in the region. The common noddy, *Anous stolidus*, is the only bird to breed in the area, using coral boulders and shipwrecks as roosting sites. Other species that have been sighted in the area include other noddies, terns, petrels and shearwaters.
	Estuaries:	Nil