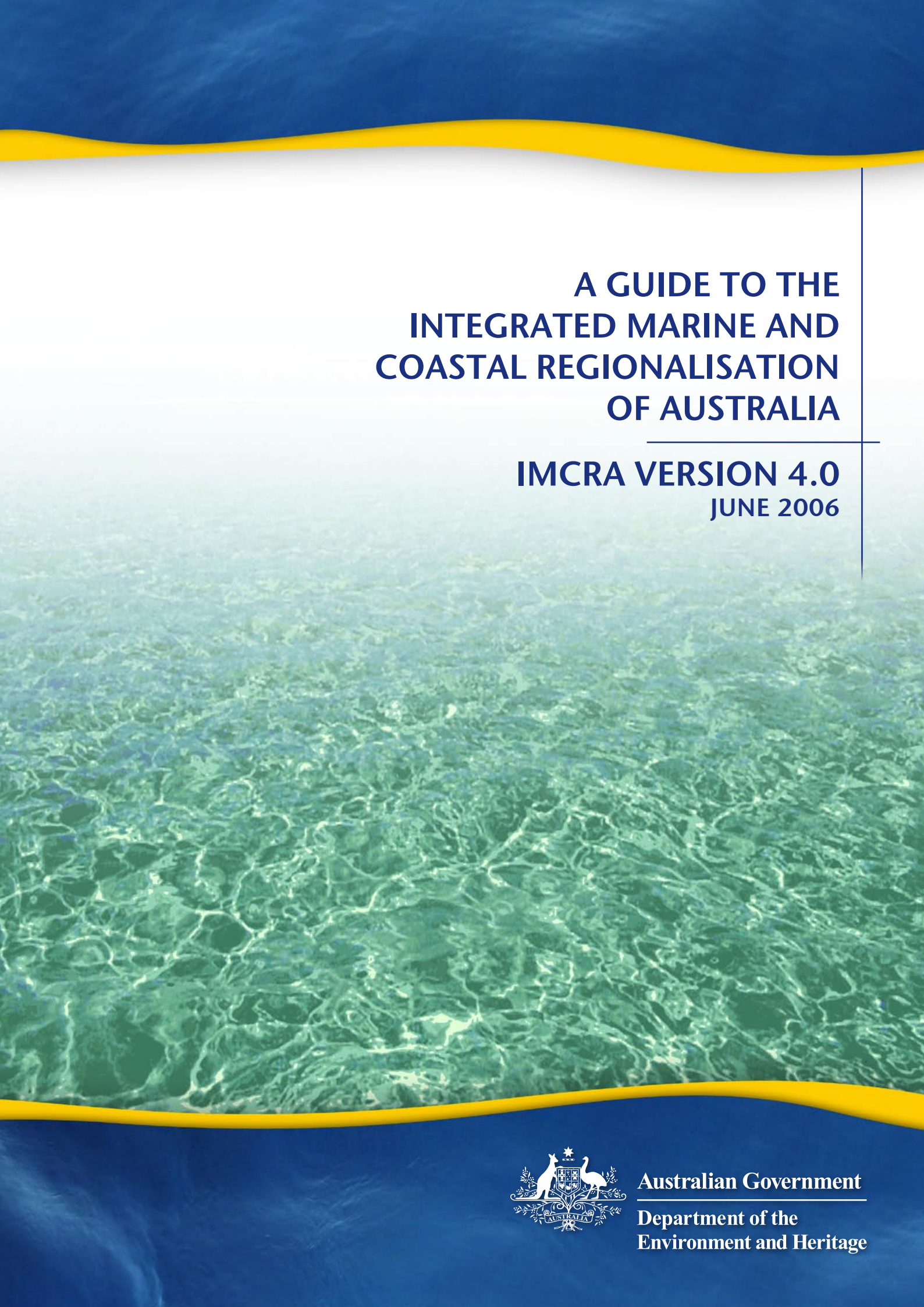
A GUIDE TO THE INTEGRATED MARINE AND COASTAL REGIONALISATION OF AUSTRALIA

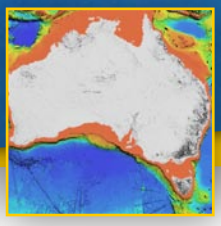
IMCRA VERSION 4.0

JUNE 2006



Australian Government
Department of the Environment and Heritage





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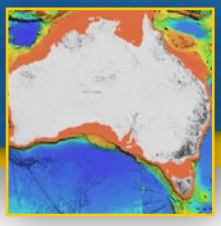


1 INTRODUCTION

1.1 Why a new version of IMCRA?

The Integrated Marine and Coastal Regionalisation of Australia (IMCRA v4.0) is a spatial framework for classifying Australia's marine environment into bioregions that make sense ecologically and are at a scale useful for regional planning. This will be a framework for subsequent finer levels of planning and management.

IMCRA v.4.0 is the product of the combination of the Interim Marine and Coastal Regionalisation of Australia (IMCRA v3.3), which provided a marine regionalisation of inshore waters, with the National Marine Bioregionalisation (NMB) for off-shelf waters. In combining the two national scale marine regionalisations, IMCRA v4.0 covers Australia's waters from the coast to the edge of the Exclusive Economic Zone excluding Antarctica and Heard and Macdonald Islands.

1.2 Rationale for and application of marine regionalisations

The Australian Government is committed to ecologically sustainable development (ESD) in Australia's oceans. *Australia's Oceans Policy* (1998) sets in place the framework for ESD for all of Australia's marine jurisdictions through integrated and ecosystem-based planning and management.

Regionalisations provide spatial frameworks that have applications for many aspects of natural resource management. They are based on collated data and inferred patterns across a variety of spatial scales and are an accepted tool to assist in the description of ecosystem boundaries for planning and management in the natural environment. Marine regionalisations help managers to understand complex ecosystems and their specific management needs.

Marine planning and management
Regionalisations contribute to an improved understanding of the wide variety of marine environments and form an important input to planning and management decisions that may be made at different spatial scales. As a tool for organising spatial information, regionalisations are important for conservation, education, science, environmental inventories, delineation of biophysical distributions and the development of management policies and organisation of management activities.

A National Representative System of Marine Protected Areas
Australia's National Representative System of Marine Protected Areas (NRSMPA) aims to establish and manage a comprehensive, adequate and representative system of marine protected areas to contribute to the long-term ecological viability of marine and estuarine systems, to maintain ecological processes and systems, and to protect Australia's biological diversity at all levels.

The guidelines for developing the NRSMPA establish IMCRA as the national and regional framework for the NRSMPA.

Other applications
Regionalisations can also be used as spatial frameworks for:

- decision-making (e.g. in assessing applications for permits);
- identifying areas that have particular values for conservation or use (e.g. Great Barrier Reef Marine Park Authority 2004);
- finer-scale habitat mapping (e.g. Northwest Shelf Joint Environmental Study 2002; Great Barrier Reef Marine Park Authority 2004); and
- fine scale bioregional assessments as part of marine protected area planning (e.g. Edyvane 1999).

1.3 Purpose of this document

The purpose of this document is to provide a summary of IMCRA v4.0 and to present the key maps derived from the inshore regionalisation (IMCRA v3.3) and the off-shelf regionalisation (NMB) in a single document. This document briefly describes the genesis of IMCRA v4.0, the different kinds of bioregions defined for Australia's oceans and where to find information about the bioregions. For detailed descriptions of Australia's ocean bioregions refer to the IMCRA v3.3 report (IMCRA Technical Group 1998) and the NMB technical reports (summarised in DEH 2005).

2 NATIONAL-SCALE MARINE REGIONALISATIONS IN AUSTRALIA

2.1 CONCOM Regionalisation

A biogeographic or regional ecosystem classification was first developed by relevant Commonwealth, State and Territory management agencies in 1985, and 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. The regionalisation delineated and described the major coastal and marine regions at the provincial scale, however the classification was generalised, broad scale and lacked sufficient details to assist detailed bioregional conservation planning.

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

2.2 IMCRA v3.3

IMCRAv3.3 was developed through the collaborative efforts of State, Northern Territory and Australian Government marine management and research agencies. Work on State and Northern Territory projects began in 1992, while work on regionalisations for Commonwealth waters began in 1995. The final products of the IMCRA v3.3 regionalisation were endorsed by the then Australian and New Zealand Environment and Conservation Council (now now replaced by the Natural Resource Management Ministerial Council) in 1998.

IMCRAv3.3 contains two provincial-level regionalisations: demersal and pelagic. The demersal regionalisation is based on a classification of demersal fish species diversity and richness, and defines 17 continental shelf provinces and biotones that are grouped by climate characteristics in tropical to temperate waters. The pelagic regionalisation describes four continental shelf provinces and biotones based on pelagic fish species diversity and richness, as well as nine classes of water mass types in deep water beyond the continental shelf.

The main product of IMCRA v3.3 was an inshore regionalisation that consisted of 60 meso-scale regions (hundreds to thousands of kilometres). These are distributed around Australia in the area extending from the coast to the edge of the continental shelf (defined as the 200 m isobath). The meso-scale regions were defined using biological and physical information, including the distribution of demersal fishes, marine plants and invertebrates, sea floor geomorphology and sediments, and oceanographic data. The best available data and analyses were used to determine boundaries in inshore waters. The data used varied among the different jurisdictions of Australian governments.

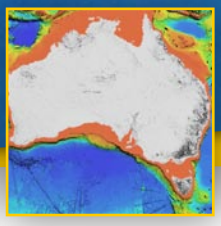
The IMCRA v3.3 report is available at www.deh.gov.au/imcra and the data are available through www.deh.gov.au/metadataexplorer/explorer.jsp (by searching for IMCRA).

2.3 National Marine Bioregionalisation

The National Marine Bioregionalisation was completed and launched by the Australian Government Minister for the Environment and Heritage, Senator the Hon Ian Campbell, in 2005. It extends the regionalisation of Australia's marine jurisdiction from the continental shelf to the edge of the EEZ. It focused on waters beyond the continental shelf that were not the focus of IMCRA v3.3.

Like IMCRA v3.3, there are two key components of the National Marine Bioregionalisation: a benthic bioregionalisation and a pelagic regionalisation. The benthic bioregionalisation describes spatial patterns on or near the sea floor. Provincial bioregions are described largely on the basis of patterns of bottom-dwelling fish diversity and on the distribution of habitats in very deep water. The NMB differs from IMCRA v3.3 in that the continental slope is divided into biomes, which are depth-related areas derived from the distribution of fish species. Geomorphic units are also described based on clusters of identified geomorphic features of the sea floor. Additional information about sediment characteristics and





mobility on parts of the continental shelf and patterns in the distribution of tropical sponges is provided to assist in the interpretation of provincial bioregions.

The NMB pelagic regionalisation covers off-shelf waters and describes structure within the water column of Australia's oceans. In the pelagic regionalisation, structures including ocean zones and water masses are based on the characteristics of the water column such as oxygen content, salinity and temperature. These represent discrete water bodies that may influence patterns in the distribution of biota and are consistent with the off-shelf water masses defined in IMCRA v3.3. Finer-scale features such as circulation regimes or oceanographic features are defined based on currents, primary productivity and energetics of the sea surface.

Further details on the NMB and its underlying data are available electronically on a DVD from the Department of the Environment and Heritage and through www.deh.gov.au/imcra.

3 IMCRA v4.0

The purpose of regionalisation is to assist in simplifying the complex relationship between environment and species distributions, and to capture spatial patterns in the distribution of species and habitats at differing scales. IMCRA v4.0 has a structure that incorporates information about patterns and processes which occur at different spatial scales.

IMCRA v4.0 consists of two separate regionalisations: a benthic bioregionalisation based on biogeography of fish supplemented with a geophysical classification; and a pelagic regionalisation based on oceanographic characteristics of water bodies.

3.1 Benthic bioregionalisation

The benthic bioregionalisation incorporates three separate layers of information:

1. *Provincial bioregions that reflect biogeographic patterns in distributions of bottom-dwelling fish.* Provincial bioregions were defined for the continental shelf for IMCRA v3.3, and for the continental slope for the NMB using similar analytical techniques. In both cases the distributions of demersal (bottom-dwelling) fish were plotted onto a line divided into equally spaced sections. The number of species in each section and the similarity between sections were calculated using a statistical tool called the Jaccard Index. Where the Jaccard Index changed greatly between sections a boundary was defined indicating differences in species assemblages between regions.
2. *Meso-scale regions on the continental shelf.* These were identified by each State and the Northern Territory for IMCRA v3.3 using regional biological and physical information. These same meso-scale regions have been retained in IMCRA v4.0.
3. *Geomorphic units for the whole of the EEZ.* These units have been defined by clustering of geomorphic features into 14 categories and mapping areas of similar geomorphology.

Provincial bioregions

Two types of provincial bioregions are defined in the benthic bioregionalisation: *provinces*, which represent regions of biotic endemism; and *transitions*, which generally occur between the provinces, and are less well-defined mixing areas that capture the overlap of demersal fish species ranges between the provinces.

There are 41 provincial bioregions defined in Australia's waters, comprising 24 provinces and 17 transitions (Map 1). These provincial bioregions can be classified into tropical, subtropical, warm temperate and cool temperate climatic zones based on the climate characteristics of the surrounding waters.

Each province can be characterised by a suite of endemic fish species. Details can be found for slope provinces in the benthic bioregionalisation report (Heap et al. 2005) and the technical report describing the biogeographical analysis of demersal fish (Last et al. 2005).

Meso-scale regions

There are 60 meso-scale regions on the continental shelf, defined using biological and physical information and geographic distance along the coast (Map 2). Detailed descriptions of the meso-scale regions can be found in the report for IMCRA v3.3 (IMCRA Technical Group, 1998).

Geomorphic units

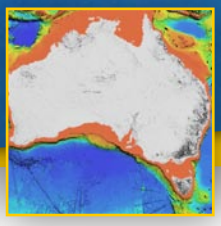
There are 1,334 separate geomorphic units in Australia's waters, in 14 categories (Map 3). These represent areas that have similar geomorphological characteristics (e.g. areas of the continental slope that contain canyons, or flat plains). Further details about geomorphic units can be found in Heap et al. (2005).

Other layers

In addition to the national scale layers for IMCRA v4.0, additional data are available from the NMB to interpret bioregions. These data include:

- Geomorphic features of the seafloor;
- Sponge biogeography in northern Australia;
- Sediment characteristics and mobility on the continental shelf in some parts of Australia;
- Tidal and wave energy at the seafloor on the continental shelf in some parts of Australia;
- Ocean crustal age and sedimentary basins; and
- Oceanographic characteristics at the seafloor.





3.2 Pelagic regionalisation

The pelagic regionalisation is divided into continental shelf and offshore components. The continental shelf regionalisation divides the continental shelf into four provincial bioregions based on classification of pelagic fish species diversity and richness. Descriptions can be found in the IMCRA v3.3 report (IMCRA Technical Group 1998).

The offshore pelagic regionalisation divides Australia's offshore waters into three-dimensional water masses and adds detail about sea surface circulation patterns and energetics at a regional scale. Water properties and circulatory regimes are highly depth-structured, and can also change rapidly through time. The pelagic regionalisation considers spatial complexity in the delineation of regions and is also based on oceanographic data that are averaged through time to accommodate a component of the temporal variation. Pelagic regions have been described for Australian waters beyond the continental shelf and between 90–180°E, 0–60°S.

Offshore water masses

25 water masses have been defined for Australia's offshore waters (Figure 1). Water masses are defined largely by latitudinal oceanographic processes with exceptions in the equatorial and tropical areas. The water masses are three-dimensional in nature and occur across different latitudes and depths. Generally, the water masses with the largest volumes are those in deeper water, with a few exceptions associated with intermediate waters. Full details can be found in the NMB report (DEH 2005) and in the technical report for the pelagic regionalisation (Lyne et al. 2005).

Figure 1 (opposite) illustrates the three-dimensional nature of water masses.

Circulation regimes and energetics

Circulation regimes were only determined for the 10 water masses that were present on the ocean surface (Figure 2). In general, the structure within the water masses is associated with circulatory fields such as the East Australian Current, the Tasman Sea and to the south and east of landmass extensions or corners; for example, the south-west of Western Australia (the Naturaliste Plateau), Tasmania and its associated subsurface shelf extensions (South Tasman Rise, Cascade Plateau), and New Zealand and its surrounding subsurface plateaus (e.g. Campbell Plateau). Details are in Lyne et al. (2005).

Figure 2 (opposite) shows oceanographic features within Australia's Marine Jurisdiction.

3.3 Where to find data, further information

IMCRA v4.0 is available at www.deh.gov.au/imcra. The reports, data layers and fact sheets about bioregions are available on DVD from the Department of the Environment and Heritage.

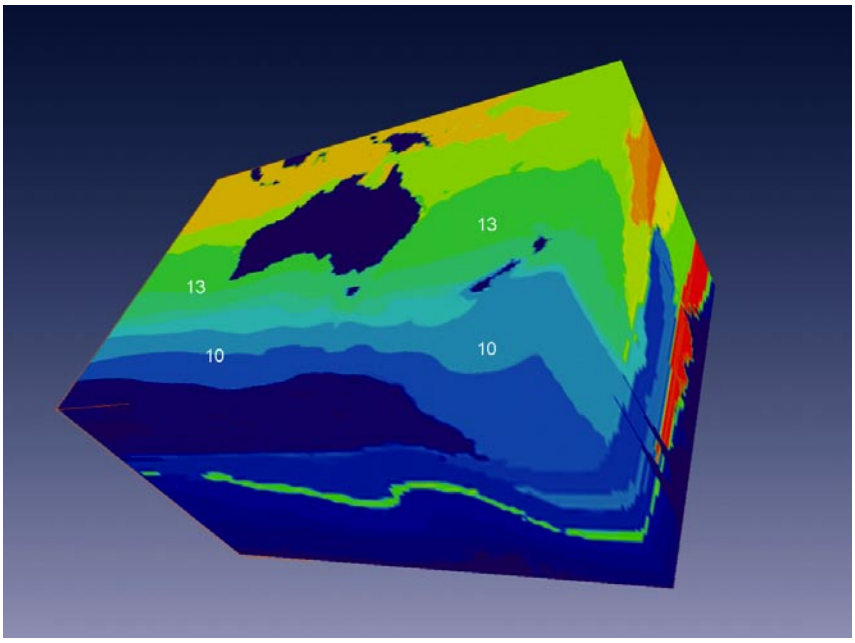


Figure 1. Image demonstrating the three-dimensional nature of water masses defined in the pelagic regionalisation. For example, water mass 13 in the Pacific Ocean is the Pacific Central-South subtropical water (coloured green) and extends from the surface waters to around 250 m depth. Water mass 10 (the southern Subtropical Convergence - coloured light blue) is part of the Southern Ocean, and extends from the surface to around 800 m depth. (Image produced using a demonstration version of Amira.)

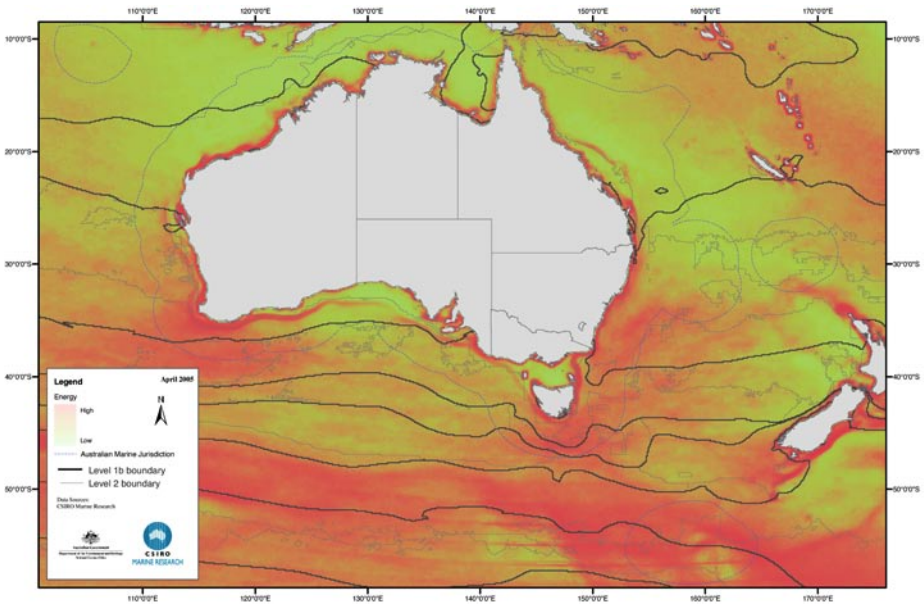
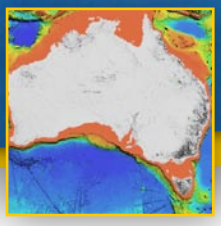


Figure 2. Oceanographic features within Australia's Marine Jurisdiction. This finest level of the regionalisation is used to identify areas of varying energetics within each of the circulation regimes. This is achieved by using relative brightness to correspond with areas of higher energy. For example, redder areas correspond to greater levels of energy, which may reflect higher productivity areas within a circulation regime. The surface water masses (black lines) and circulation regimes (grey lines) are also marked on the map to illustrate the relationship among all three levels of the regionalisation.





4 FUTURE DEVELOPMENT OF IMCRA

4.1 Scope for development

Marine regionalisation in Australia has progressed greatly since the IMCRA v3.3 was completed in 1998. Nevertheless, further development when additional data become available will add significant value to the marine bioregionalisation as a framework for planning and management.

In developing the National Marine Bioregionalisation and the updating of IMCRA the following areas were identified that if addressed could improve the utility of IMCRA:

- conceptual classification models;
- data coverage; and
- ecosystem understanding and ecosystem surrogates.

These should be progressed before a major revision is considered.

Conceptual classification models

Increasing international and national commitments to an ecosystem basis for marine management, the ability to report on the effectiveness of management and the necessary governance arrangements to support these activities will place increasing demands on the use of the regionalisation (and the associated data sets) as a management tool.

Clarification of the way that processes and attributes are expressed and classified in space and time at multiple scales and the links between these scales and their application to management will require continued attention.

Data coverage

Work that continues to build on existing datasets and collate existing data is the most cost-effective way of adding value to the bioregionalisation.

The demersal fish data that have been used to define benthic provincial bioregions are split into a dataset for the continental shelf and a separate dataset for the continental slope. These two datasets should be merged and re-analysed to investigate finer-scale patterns in demersal fish distributions.

The existing sponge dataset covers northern Australia only. There are collections in the South Australian and Western Australian museums that could be added to the dataset to create national-scale information on distributions of sponges. In addition, the existing sediments dataset only covers the continental shelf in parts of Australia. Un-analysed samples already exist to fill a large gap in South-west Australia. A project to analyse these samples would substantially add value to the sediment database. In time, further sampling and analysis to add data from the continental slope and abyss should be undertaken.

Effort should be directed to collating distributional data on additional biological groups that are taxonomically stable, biogeographically informative (i.e. have large numbers of species with narrow distributional ranges) and are well represented in museum collections. Good candidates for these datasets include echinoderm and decapod collections which are already well documented and need only be digitised to add significant value to existing biodiversity datasets.

A key way to add value to IMCRA v4.0 is to ensure that data from other programs are linked to the bioregionalisation through data-sharing initiatives such as the Oceans Biogeographic Information System, the Global Biodiversity Information Facility, the Australian Oceans Data Centre Joint Facility, the Oceans Portal, the Online Zoological Catalogue of Australian Museums, Bluenet and others. Close links also need to be maintained with a range of initiatives, including habitat mapping/classification and biodiversity surveys such as the Great Barrier Reef Seabed Biodiversity project, the Census of Marine Life, Torres Strait habitat mapping and National Facility cruises.

Ecosystem understanding and ecosystem surrogates

A clear need exists for ongoing further research, including research into the links between benthic and pelagic systems, testing assumptions of surrogacy (both biological and physical surrogates) and inclusion of both temporal and fine-scale spatial heterogeneity in the regionalisations. In addition, research is required into analytical methods for large and complex datasets and techniques for visualisation of complex three- and four-dimensional models of the ocean.

4.2 Process for update

Application of IMCRA v4.0 to management and planning will drive the need for its development. It is anticipated that IMCRA v4.0 will be revised no sooner than 2010. A new version should incorporate more biological data, particularly in the pelagic environment, more detailed descriptions of the ecological components and processes of deep water systems, and links between the benthic and pelagic environments.

While a complete revision will not occur before 2010, minor updates may be required to particular boundaries in the interim. Triggers for updating boundaries in IMCRA v4.0 include:

- Substantial new data on biodiversity or ecosystem processes either in a region or nationally;
- Proposed need by a jurisdiction or jurisdictions (i.e. data not adequate for planning); and
- Need to demonstrate ongoing exploration of seafloor as part of Australia's obligations under the United Nations Convention on the Law of the Sea.

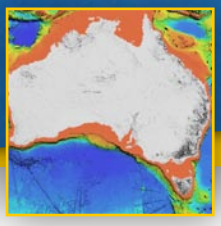
The Australian Government Department of the Environment and Heritage (DEH) is the custodian of IMCRA 4.0. The role of custodian includes maintaining oversight of the conceptual framework for the regionalisation, coordinating consultation amongst jurisdictions and agencies affected by a proposed change to boundaries and keeping jurisdictions informed of proposed changes and/or the need for major revision of the products through the Marine and Coastal Committee of the Natural Resource Management (NRM) Ministerial Council.

Any jurisdiction may request a change to agreed boundaries of IMCRA 4.0 (as shown in Appendix 1). Jurisdictions should contact the DEH to negotiate changes. All agencies with a stake in the proposed change should be consulted about any changes to be made and participate in the formal sign-off process prior to notification to DEH. DEH will coordinate this process and the notification to the Marine and Coastal Committee of the NRM Ministerial Council.

Any major national revisions should be agreed in advance by the NRM Steering Committee via the Marine and Coastal Committee and then presented for formal ratification.

The version of IMCRA hosted through the DEH website www.deh.gov.au/imcra is the authoritative source of IMCRA data layers. Any new planning, monitoring or management activities should be based on the most recent version, which will be clearly identified on the website.





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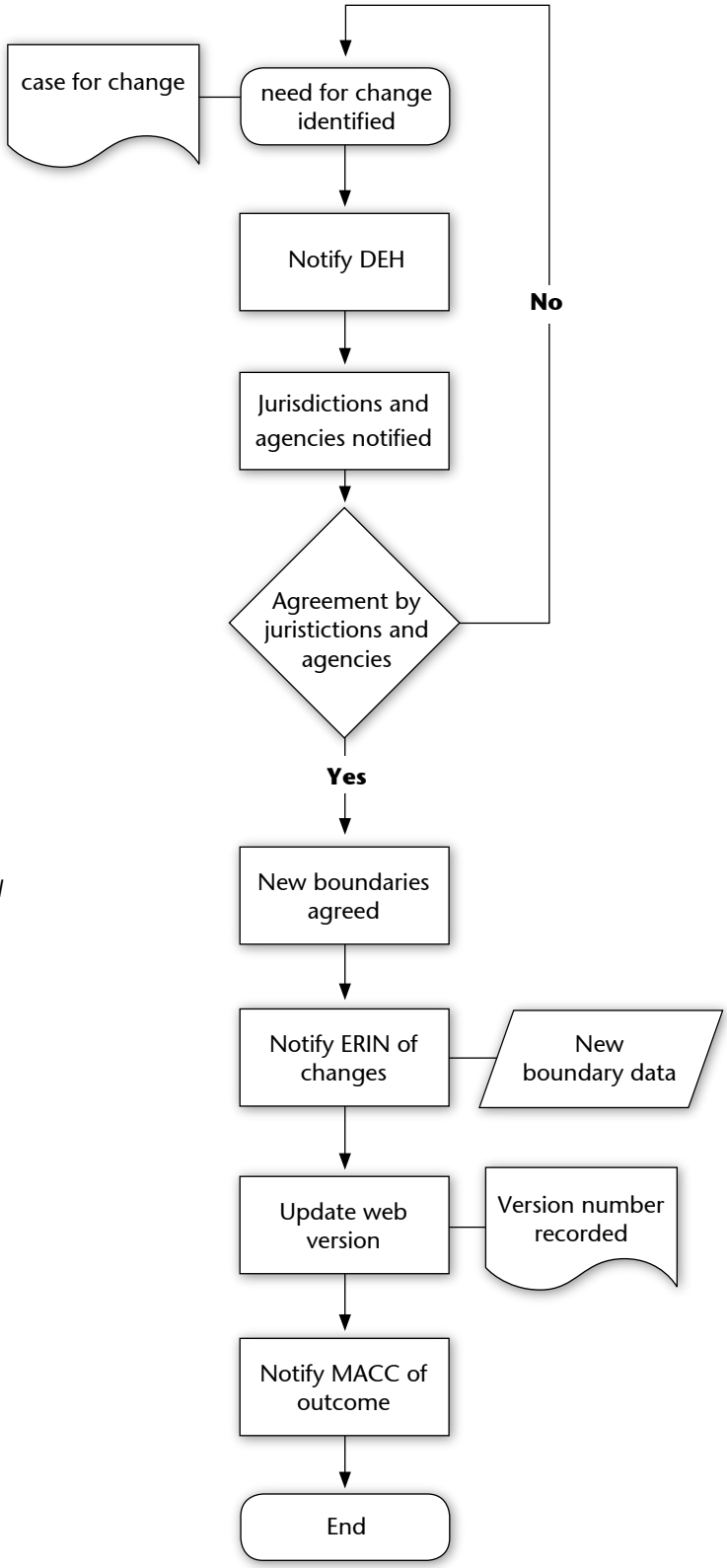
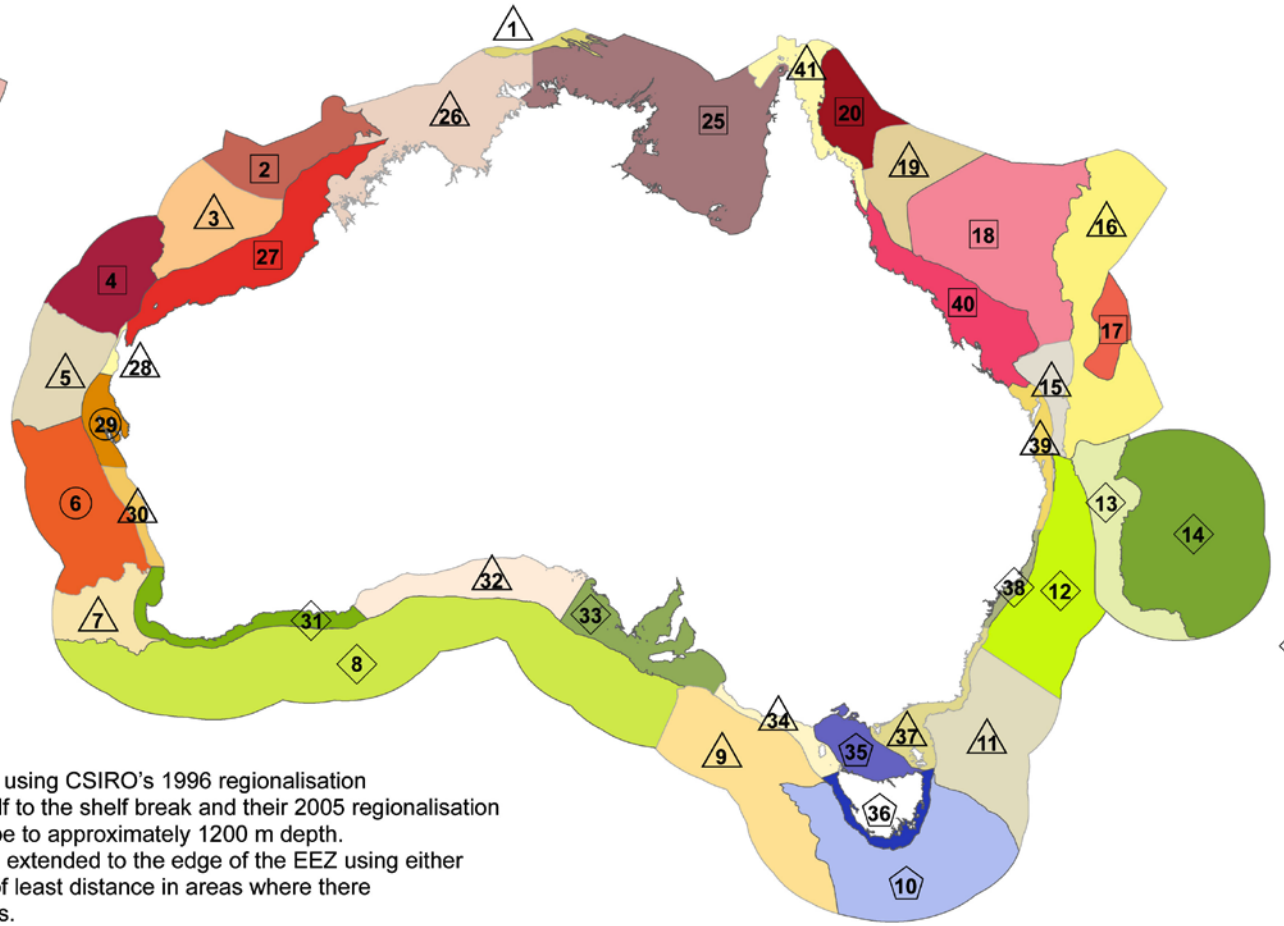
Appendix 1:
Process for updating IMCRA boundaries



Map 1 IMCRA 4.0: Provincial Bioregions



Tropical waters
2, Timor Province
4, Northwest Province
17, Kenn Province
18, Northeast Province
20, Cape Province
22, Cocos (Keeling) Island Province
23, Christmas Island Province
25, Northern IMCRA Province
27, Northwest IMCRA Province
40, Northeast IMCRA Province

Subtropical waters
6, Central Western Province
29, Central Western IMCRA Province

Transition
1, Timor Transition
3, Northwest Transition
5, Central Western Transition
7, Southwest Transition
9, West Tasmania Transition
11, Southeast Transition
15, Central Eastern Transition
16, Kenn Transition
19, Northeast Transition
26, Northwest IMCRA Transition
28, Central Western IMCRA Transition
30, Southwest IMCRA Transition
32, Great Australian Bight IMCRA Transition
34, Western Bass Strait IMCRA Transition
37, Southeast IMCRA Transition
39, Central Eastern IMCRA Transition
41, Northeast IMCRA Transition

Warm temperate waters
8, Southern Province
12, Central Eastern Province
13, Tasman Basin Province
14, Lord Howe Province
21, Norfolk Island Province
31, Southwest IMCRA Province
33, Spencer Gulf IMCRA Province
38, Central Eastern IMCRA Province

Cold temperate waters
10, Tasmania Province
24, Macquarie Island Province
35, Bass Strait IMCRA Province
36, Tasmanian IMCRA Province

BACKGROUND
The provincial bioregions were defined using CSIRO's 1996 regionalisation of demersal fish on the continental shelf to the shelf break and their 2005 regionalisation of demersal fish on the continental slope to approximately 1200 m depth. Continental slope provinces have been extended to the edge of the EEZ using either geomorphological features or the line of least distance in areas where there were no distinguishing seafloor features.

Core provinces are centres of demersal fish endemicity.
Transitions are regions of overlap between core provinces.

CAVEATS
1.Provincial boundaries below 1200m are based on geomorphological surrogates in the absence of biological data for deep waters.
2.Shelf and slope provinces have been defined in separate analyses.

Australian Government Data Sources
DEH(1998): IMCRA v3.3 Shelf demersal fish regionalisation
CSIRO(2004):National Demersal Fish Datasets for the regionalisation of the Australian continental slope and outer shelf (slope)
GA(2002): Primary Bathymetric Units of Australia's EEZ
GA(1990):Australia, Coastline and State Borders 1:100,000

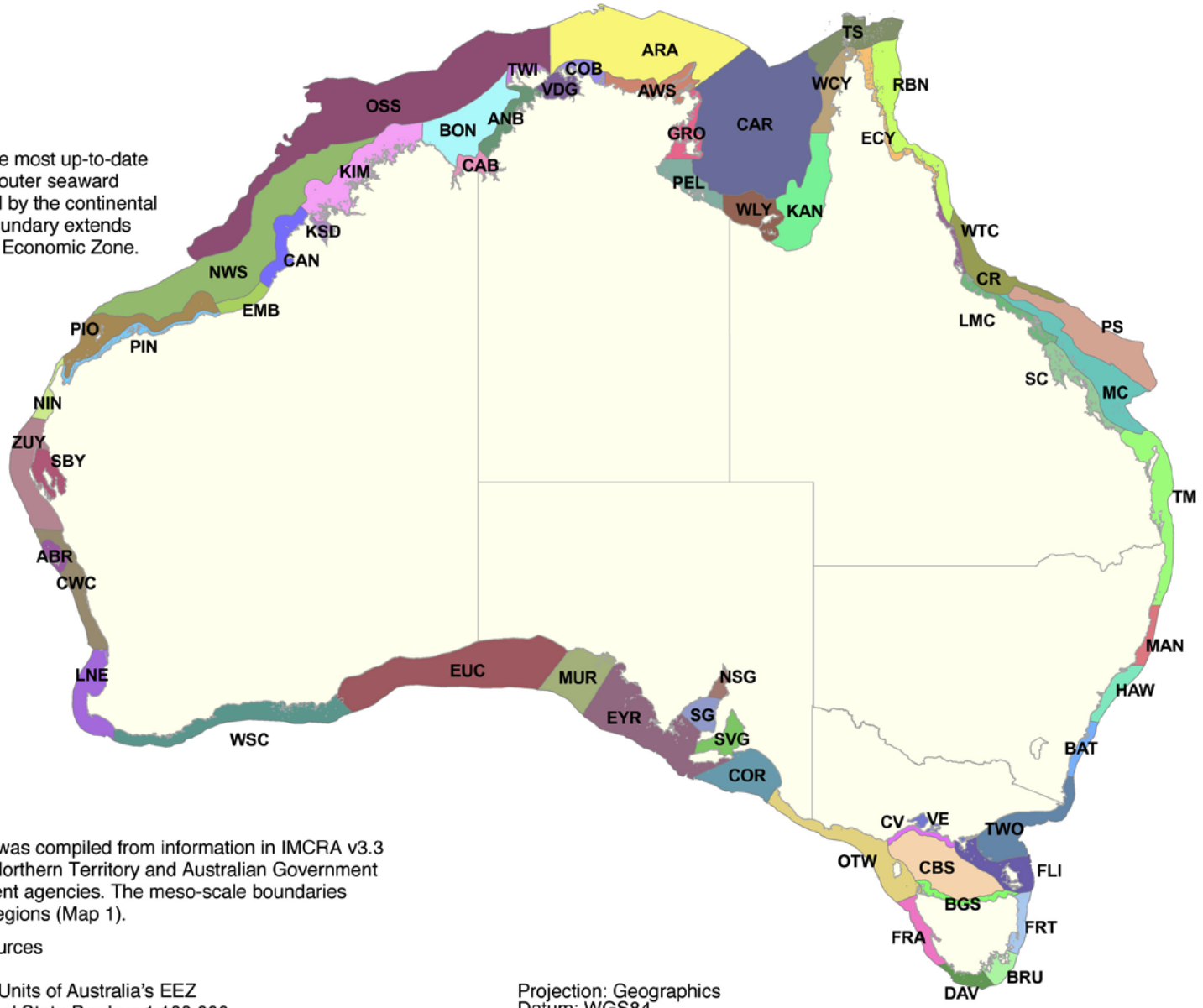
Projection: Geographics
Datum: WGS84

0 200 400 800 1,200
Approx. Kilometres

Produced by: ERIN, Department of the Environment and Heritage, Australian Government.

Map 2 IMCRA 4.0: Meso-scale Bioregions

BACKGROUND
This map was compiled using the most up-to-date data available as of 7/3/97. The outer seaward extent of the coverage is defined by the continental shelf break except where this boundary extends beyond the Australian Exclusive Economic Zone.



Bioregions
ABR, Abrolhos Islands
ANB, Anson Beagle
ARA, Arafura
AWS, Arnhem Wessel
BAT, Batemans Shelf
BGS, Boags
BON, Bonaparte Gulf
BRU, Bruny
CAB, Cambridge-Bonaparte
CAN, Canning
CAR, Carpentaria
CBS, Central Bass Strait
COB, Cobourg
COR, Coorong
CR, Central Reef
CV, Central Victoria
CWC, Central West Coast
DAV, Davey
ECY, East Cape York
EMB, Eighty Mile Beach
EUC, Eucla
EYR, Eyre
FLI, Flinders
FRA, Franklin
FRT, Freycinet
GRO, Groote
HAW, Hawkesbury Shelf
KAN, Karumba-Nassau
KIM, Kimberley
KSD, King Sound
LMC, Lucinda-Mackay Coast
LNE, Leeuwin-Naturaliste
MAN, Manning Shelf
MC, Mackay-Capricorn
MUR, Murat
NIN, Ningaloo
NSG, North Spencer Gulf
NWS, North West Shelf
OSS, Oceanic Shoals
OTW, Otway
PEL, Pellew
PIN, Pilbara (nearshore)
PIO, Pilbara (offshore)
PS, Pompey-Swains
RBN, Ribbons
SBY, Shark Bay
SC, Shoalwater Coast
SG, Spencer Gulf
SVG, St Vincent Gulf
TM, Tweed-Moreton
TS, Torres Strait
TWI, Tiwi
TWO, Twofold Shelf
VDG, Van Diemens Gulf
VE, Victorian Embayments
WCY, West Cape York
WLY, Wellesley
WSC, WA South Coast
WTC, Wet Tropic Coast
ZUY, Zuytdorp

The meso-scale regionalisation was compiled from information in IMCRA v3.3 supplied by the relevant State, Northern Territory and Australian Government marine research and management agencies. The meso-scale boundaries are nested within provincial bioregions (Map 1).

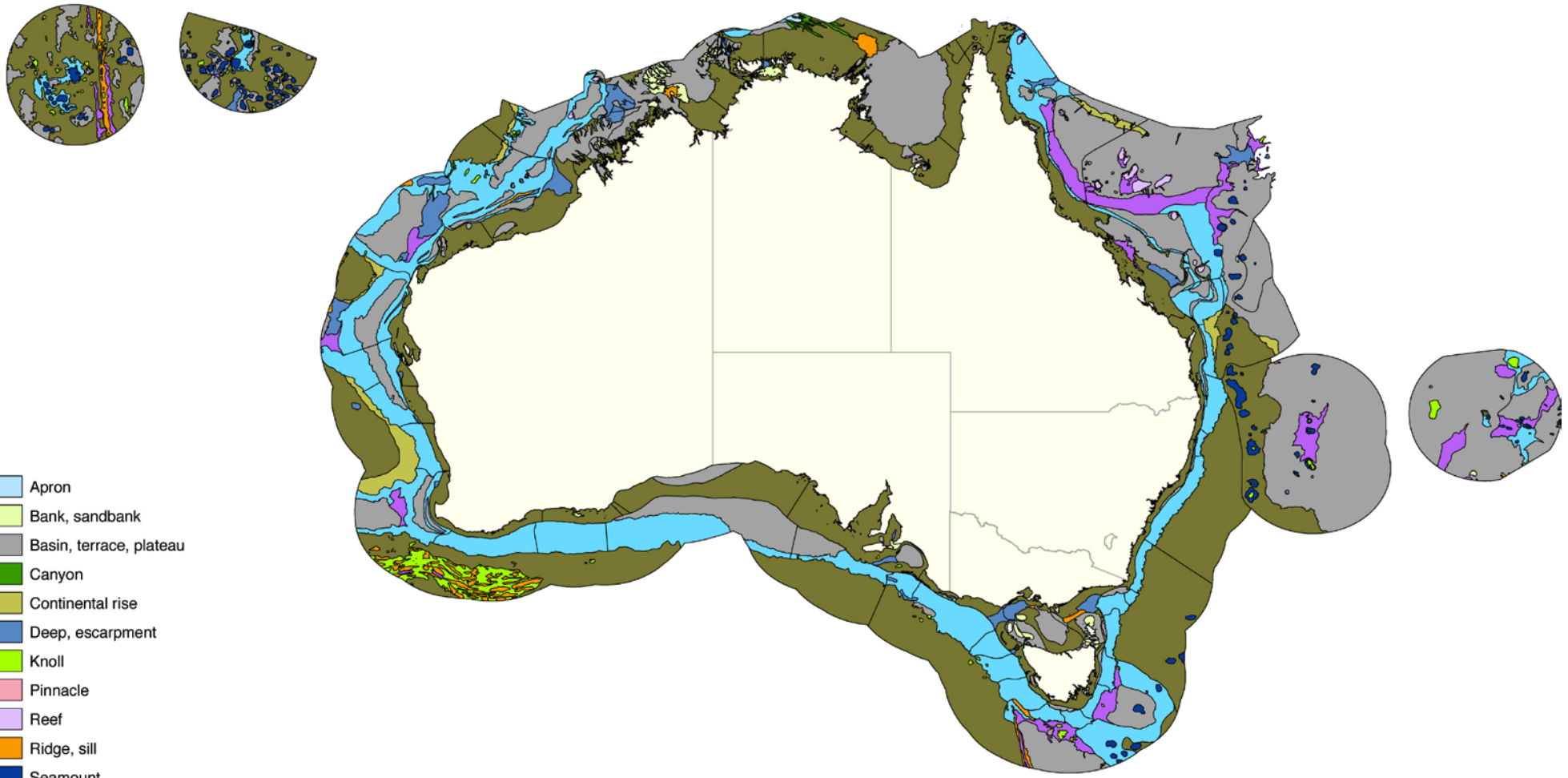
Australian Government Data Sources
DEH(1998): IMCRA v3.3
GA(2002): Primary Bathymetric Units of Australia's EEZ
GA(1990):Australia, Coastline and State Borders 1:100,000

Produced by: ERIN, Department of the Environment and Heritage, Australian Government.

Projection: Geographics
Datum: WGS84

0 200 400 800 1,200
Approx. Kilometres

Map 3 IMCRA 4.0: Geomorphic Units



- Apron
- Bank, sandbank
- Basin, terrace, plateau
- Canyon
- Continental rise
- Deep, escarpment
- Knoll
- Pinnacle
- Reef
- Ridge, sill
- Seamount
- Shelf, abyssal plain
- Slope
- Trench, saddle

BACKGROUND
Geomorphic units are the result of clustering Geoscience Australia's geomorphic features into 14 classes of regions of similar geomorphology. In addition, the continental slope has been divided into regions based on presence/absence and relative spacing of submarine canyons along the margin.

Australian Government Data Sources:
GA (2004): Geomorphic Features of the EEZ
GA(1990): Australia, Coastline and State Borders 1:100,000

Produced by: ERIN, Department of the Environment and Heritage, Australian Government.

Projection: Geographics
Datum: WGS84

0 200 400 800 1,200
Approx. Kilometres