NRSMPA Strategic Plan of Action: Status of Benthic Habitat Mapping (Action 6 – Ecosystem Mapping)

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A report to the ANZECC Task Force on Marine Protected Areas

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1. Introduction

1.1 Background to the Project

This report is one of four reports prepared as part of a project undertaken for the ANZECC Task Force on Marine Protected Areas (TFMPA). The project brief is provided in Appendix B. TFMPA is responsible for establishing a comprehensive, adequate and representative system of marine protected areas (MPAs). In July 1999, ANZECC published the *Strategic Plan of Action for the National Representative System of Marine Protected Areas: A Guide for Australian Governments* (ANZECC 1999a). The Strategic Plan sets out actions to achieve the goals of the NRSMPA.

This project addresses four of the 34 actions contained in the Strategic Plan. The reports produced under this project will together contribute to:

- providing a national review of methods of mapping of ecosystems / ecosystem components (Action 8) and mapping coverage by jurisdictions (Action 6) (it is useful to refer to the reports for Actions 6 and 8 together)
- promoting an assessment and mapping process for vulnerable marine ecosystems (Action 4)
- identifying national priorities for candidate MPAs (Action 5)

The project reports make reference to the *Interim Marine and Coastal Regionalisation for Australia (IMCRA): an ecosystem-based classification for marine and coastal environments* (IMCRA Technical Group 1998). ANZECC have agreed that IMCRA provides the national and regional planning framework for developing the National Representative System of Marine Protected Areas (NRSMPA). Within the ecosystem-based regionalisation, more detailed information on ecosystem, communities and/or species distributions can be used to assist decision-making across or within a bioregion.

1.2 Background to Action 6

Action 6: Status of "Ecosystem" Mapping for NRSMPA is a review of progress made by the jurisdictions in mapping ecosystem components, specifically benthic habitats, for the NRSMPA. It describes the coverage of mapping (used for strategic planning of MPAs) within each IMCRA meso-scale bioregion, and as a proportion of each jurisdiction's waters.

Action 6 is directly linked to Action 8 which describes the nature and definition of attributes of ecosystem components mapped by each jurisdiction (at sub-IMCRA scales). The information from Action 6 will also link to future performance assessment reporting actions (Actions 32-34), as mapping coverage of different ecosystem components at different scales would represent a useful performance indicator for progress on strategic planning for a comprehensive, adequate and representative (CAR) system of MPAs.

2. Status of Benthic Habitat Mapping

2.1 Objectives and Scope

The objective of this action is to review progress made by the jurisdictions in mapping ecosystem components so that in the future progress in strategic planning for the NRSMPA can be tracked.

Given the wide differences in purposes for mapping, mapping scales, methodologies and terminologies used (refer Figure 2.1), this action only focuses on the proportion of mapping coverage of ecosystems / ecosystem components at sub-IMCRA scales within each bioregion. Mapping of benthic habitats at these scales (ie 1:100,000) has application to the strategic planning of MPAs as it provides a surrogate for biodiversity as outlined below. Depending on the resolution and scale of mapping information this can have application for assessing the level of comprehensiveness (broader scale) and representativeness (finer scale) of candidate MPAs.

Spatial data collected in a manner that samples biodiversity directly, or as a surrogate (ie physical habitat diversity), is a basic input used to determine the extent to which a component of the marine environment is typical of its surroundings at a chosen scale. The measurement of progress in spatial data capture for the purpose of determining representativeness also defines the scope of Action 6 in so far as proportional mapping coverage is analogous to progress.

Mapping coverage is the most readily measurable of methods for spatial data capture. However, mapping coverage measurements do not provide information on the extent to which jurisdictions have collected other types of spatial data (ie point data sets) useful in the NRSMPA process. Quantitative measures of data point density and extent of non-mapping data are beyond the scope of this report.

Mapping datasets at scales below meso-scale was identified as a means of enabling consistent comparison among jurisdictions. While the term 'ecosystem' is adopted by TFMPA (ANZECC TFMPA 1999b) to describe the scale of mapping below the level of the IMCRA bioregionalisations (meso-scale), it is not used as a basis for mapping by any jurisdiction.

On the basis of consultation with marine conservation and resource managers around Australia, it was apparent that much of the spatial data used to characterise marine biodiversity at sub-IMCRA levels consisted of marine benthic habitat mapping. This was mostly undertaken in nearshore waters (<20m - 50m depth) using satellite and aerial photography remote sensing techniques with varying densities of ground truthing. The mapping involved data capture of physiographic features and occasionally supporting spatial information on the distribution of biotic habitat components. Generally, the scale of mapping inputs was based on finer scale remote sensing inputs, with sufficient resolution to justify a typical mapping output scale of 1:100,000. This scale was adopted as the reference for depicting coverage of marine benthic habitat mapping useful for the selection and evaluation of candidate representative MPAs at the sub-IMCRA level.

The finer scales of mapping focussing on MPA boundary identification, zoning and management (eg. 1:25,000 / 1:10,000 – refer Figure 2.1) are included as a small component of the coverage in this report and represent the lowest reasonable limit of mapping coverage with application to the advancement of strategic planning for the NRSMPA . The collection of local and site scale mapping (below 1:10,000) is not feasible at this time due to the wide differences in mapping purposes and outputs making overall comparison and future benchmarking of progress difficult. It is noted that the NRSMPA Strategic Plan of Action requires a report of progress on mapping at local and site scales

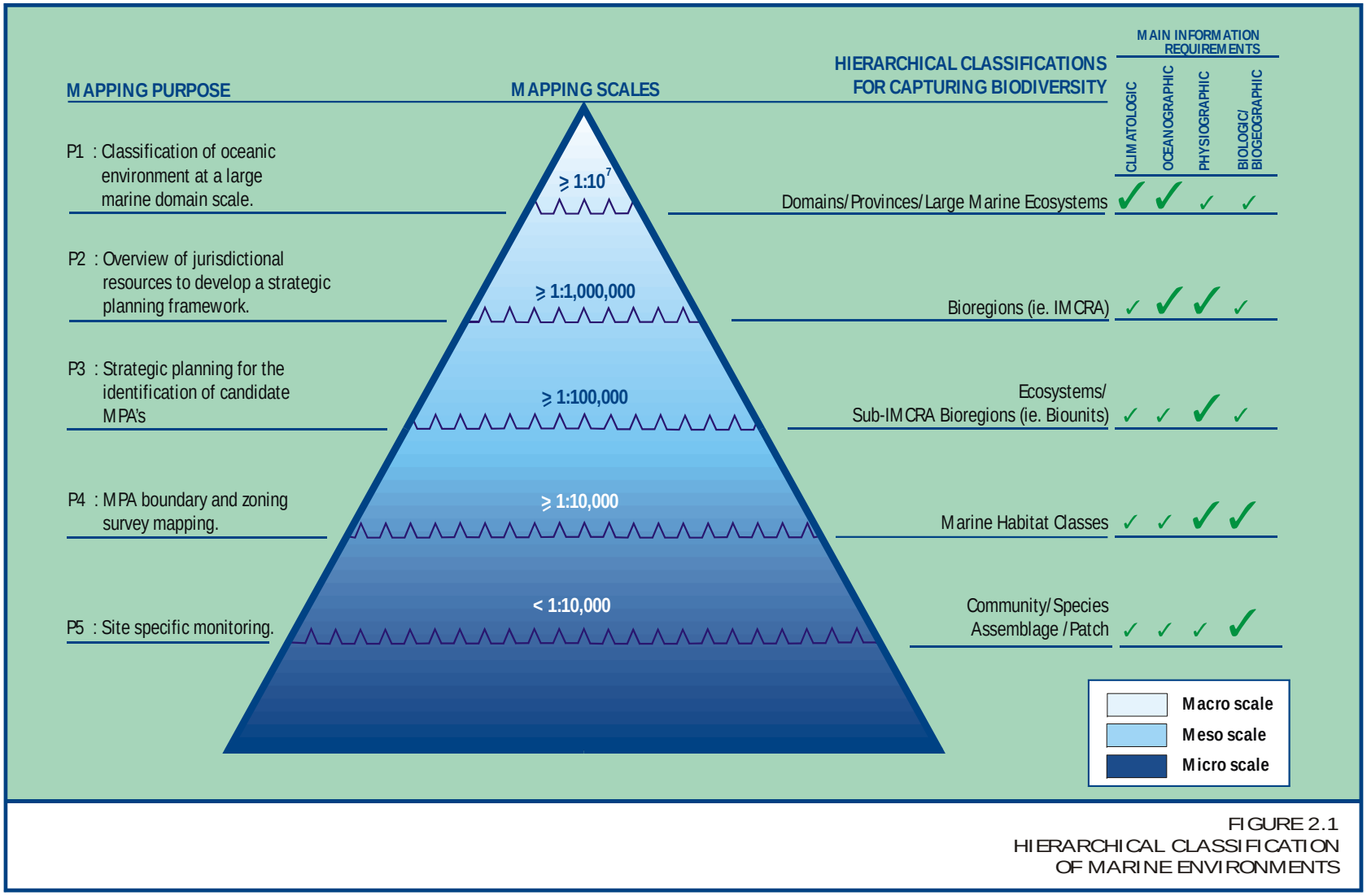

FIGURE 2.1
HIERARCHICAL CLASSIFICATION
OF MARINE ENVIRONMENTS

during 2000 – 2001. This activity would not be practical if comparisons were made out of context and among mapping datasets collected at different scales for different purposes. Progress on this activity could best be benchmarked in a qualitative manner comparing the nature and extent of mapping coverage among mapping undertaken for a common purpose (ie MPA management zoning) or of a common habitat or community type (ie seagrass coverage).

It is noted that 100% mapping coverage is unlikely to be an aim of jurisdictions, however, a low figure would be a concern as it would make justification of MPAs on the basis of comprehensiveness difficult. Instead, this report attempts to broadly reflect progress in mapping of ecosystem components below meso-scale as an indication of progress in mapping at scales useful for strategic planning of MPAs.

It is noted that mapping of differing accuracy and resolution is bulked in the accompanying tables. As a result, figures should not be compared between jurisdictions. It is beyond the scope of this report to disaggregate the different types of mapping in terms of data quality and type. A model process for this activity is presented in Section 2.3, while broad summaries of the mapping datasets are included in the report for Action 8 of the NRSMPA Strategic Plan of Action.

2.2 Coverage Presentation

The information was compiled by literature review and consultation with representatives of each jurisdiction (refer contact list in Appendix D) in which a checklist format was adopted (Appendix E).

The compilation of information followed a standard format:

- IMCRA Bioregion Name;
- IMCRA Bioregion Code;
- Jurisdiction;
- Jurisdictions Bioregion Area (sq km) (State Waters – 3 nautical miles; Commonwealth – 200 nautical miles)
- Area of Mapping in Jurisdiction's component of Bioregion (sq km);
- Percentage of Mapping within Jurisdiction's component of Bioregion.

Table 2.1 shows the progress of mapping marine benthic habitats at sub-IMCRA scales.

The Commonwealth of Australia has been listed in the table where a significant area of mapping has been undertaken by the other jurisdictions crossing over into Commonwealth waters (included within IMCRA bioregions). The area of such mapping is not great (less than 1500 sq km around Australia) and is mainly extensions of nearshore state waters mapping into Commonwealth waters off Tasmania, Bass Strait and the coast of South Australia. Where jurisdictions have mapped across boundary waters the proportion within the Commonwealth waters has been calculated against the Commonwealth's bioregion area. Where there is no significant mapping in Commonwealth waters (excluding GBRMPA), the Commonwealth component of the IMCRA bioregion is not noted in Table 2.1.

Agencies such as AGSO, AIMS and AODC have bathymetric data, acoustic characterisation data, sediment samples, RAN Hydrographic surveys and other databases (refer Report for Action 8 for listing). These databases exist over all Commonwealth waters, however, the level of detail differs greatly. The extent of CSIRO benthic habitat mapping in the Gulf of Carpentaria is not reported.

Table 2.1: Coverage of Marine Benthic Habitat Mapping by IMCRA Bioregion

IMCRA Bioregion	Code	Jurisdiction	Jurisdictions Bioregion Area (sq km)	Area of Mapping in Jurisdictions component of Bioregion (sq km)	% of Mapping in Jurisdictions component of Bioregion
Abrolhos Islands	ABR	WA	2,467	493	20
Anson Beagle	ANB	NT	12,869	2050	16
Arafura	ARA	NT	2,010	0	0
Arnhem Wessel	AWS	NT	17,417	0	0
Batemans Shelf	BAT	NSW	1,912	0	0
Boags	BGS	TAS	4,342	980	23
Boags	BGS	Cth	3,929	278	7
Bonaparte Gulf	BON	WA	3,084	0	0
Bruny	BRU	TAS	4,043	443	11
Bruny	BRU	Cth	3,245	55	2
Cambridge – Bonaparte	CAB	WA	2,250	0	0
Cambridge – Bonaparte	CAB	NT	7,650	0	0
Canning	CAN	WA	3,728	0	0
Carpentaria	CAR	NT	956	0	0
Central Bass Strait	CBS	Cth	50,331	0	0
Central Reef	CRF	QLD	1,515	0	0
Central Reef	CRF	GBRMPA	31,233	31,233	100
Central Victoria	CVA	VIC	1,657	553	33
Central West Coast	CWC	WA	3,716	743	20
Cobourg	COB	NT	7,099	0	0
Coorong	COR	SA	2,671	1,231	46
Coorong	COR	Cth	29,301	440	1.5
Davey	DAV	TAS	2,050	183	9
Davey	DAV	Cth	4,744	18	0.4
East Cape York	ECY	QLD	13,332	816	6(S)
East Cape York	ECY	GBRMPA	10,506	10,506	100
Eighty Mile Beach	EMB	WA	1,684	0	0
Eucla	EUC	SA	1,945	499	26
Eucla	EUC	WA	3,763	0	0
Eyre	EYR	SA	20,120	4,242	21

IMCRA Bioregion	Code	Jurisdiction	Jurisdictions Bioregion Area (sq km)	Area of Mapping in Jurisdictions component of Bioregion (sq km)	% of Mapping in Jurisdictions component of Bioregion
Eyre	EYR	Cth	52,044	17	<0.1
Flinders	FLI	VIC	1,100	472	43
Flinders	FLI	TAS	3,338	1258	38
Flinders	FLI	Cth	13,578	761	6
Franklin	FRA	TAS	2,347	511	22
Franklin	FRA	Cth	8,017	142	2
Freycinet	FRT	TAS	3,277	350	11
Freycinet	FRT	Cth	4,802	42	0.9
Groote	GRO	NT	17,083	0	0
Hawkesbury Shelf	HAW	NSW	2,192	0	0
Karumba-Nassau	KAN	QLD	4,702	2,626	59 (S)
Kimberley	KIM	WA	31,531	0	0
King Sound	KSD	WA	4,200	0	0
Leeuwin-Naturaliste	LNE	WA	3,399	1,020	30
Lucinda-Mackay Coast	LMC	QLD	12,904	496	4 (S)
Lucinda-Mackay Coast	LMC	GBRMPA	6,589	6,589	100
Mackay-Capricorn	MCN	QLD	5,342	0	(S)
Mackay-Capricorn	MCN	GBRMPA	52,618	52,618	100
Manning Shelf	MAN	NSW	1,761	0	0
Murat	MUR	SA	5,138	784	15
Ningaloo	NIN	WA	2,124	2,124	100
North Spencer Gulf	NSG	SA	4,448	4,413	99
North West Shelf	NWS	Cth	135	68	50
Oceanic Shoals	OSS	Cth	1498	0	0
Oceanic Shoals	OSS	NT	384	0	0
Otway	OTW	VIC	1,925	928	48
Otway	OTW	TAS		0	0
Otway	OTW	SA	1,258	679	54
Pellew	PEL	NT	9,461	0	0
Pilbara (nearshore)	PIN	WA	12,519	1,252	10
Pilbara (offshore)	PIO	WA	10,993	1,099	10

IMCRA Bioregion	Code	Jurisdiction	Jurisdictions Bioregion Area (sq km)	Area of Mapping in Jurisdictions component of Bioregion (sq km)	% of Mapping in Jurisdictions component of Bioregion
Pompey – Swains	PSS	GBRMPA	56,374	56,374	100
Ribbons	RBN	QLD	13,668	0	(S)
Ribbons	RBN	GBRMPA	41,263	41,263	100
Shark Bay	SBY	WA	14,071	7,035	50
Shoalwater Coast	SCT	QLD	18,430	1,024	6(S)
Shoalwater Coast	SCT	GBRMPA	6,393	6,393	100
Spencer Gulf	SGF	SA	11,875	4,511	38
St Vincent Gulf	SVG	SA	12,838	3,700	29
Tiwi	TWI	NT	2,477	0	0
Torres Strait	TST	QLD	6,210	0	0
Tweed-Moreton	TMN	NSW	1,896	1,896	100
Tweed-Moreton	TMN	QLD	10,867	210	2(S)
Tweed-Moreton	TMN	GBRMPA	4,490	4,490	100
Twofold Shelf	TWO	VIC	1,998	828	41
Twofold Shelf	TWO	NSW	813	0	0
Van Diemen Gulf	VDG	NT	17,010	0	0
Victorian Embayments	VES	VIC	3,370	3,370	100
WA South Coast	WSC	WA	12,794	2,559	20
Wellesley	WLY	QLD	7,817	0	(S)
Wellesley	WLY	NT	471	0	0
West Cape York	WCY	QLD	5,647	580	10 (S)
Wet Tropic Coast	WTC	QLD	4,377	12	0.3 (S)
Wet Tropic Coast	WTC	GBRMPA	2,383	2,383	100
Zuytdorp	ZUY	WA	3,788	0	0

Note:

WA, SA and NSW - figures have been generated from estimates, not from a Geographic Information System

2.3 Quality and Reliability of Data

The mapping coverage data presented in this section are highly variable with respect to their scope, resources and the precise purpose for which they were collected. In particular, the ultimate resolution of mapping depends on the intensity of ground truthing. For example, among jurisdictions with comparable ground truthing resources but greatly different lengths or diversity of coastline character

one expects higher levels of resolution and accuracy of mapping where ground truthing resources are able to be concentrated. The purpose of mapping varies between mapping for the strategic planning of MPAs as opposed to broad resource inventory or specific site or resource management imperatives. This variability is reflected in the different levels of quality and reliability of the data due to the extent and intensity of ground truthing; the resolution of the data capture methods used; and the accuracy of the means of transferring and presenting the spatial data. The NRSMPA Strategic Plan Report for Action 8 summarises the methods of data capture used by the jurisdictions to enable consideration of the similarities and differences in the quality and reliability of benthic habitat mapping coverage datasets.

This section puts forward a model to enable the characterisation of the quality and reliability of the mapping data in order to improve the validity of comparison among mapping datasets in different bioregions.

Data quality relates to how well (positional accuracy, consistency and completeness) and how many iterations or processes it has taken to transfer the data collected in the field to a computer based map (ANZLIC 1999). Data quality will certainly vary according to the precision of tools used in the field and the tolerances and precision of the tools used in converting this data into a digital map. Agencies such as AUSLIG and ERIN have documented data standards (refer Appendix E for extracts) and with the introduction of ISO standards for spatial data later this year, every jurisdiction should be preparing for implementation a minimum standards document similar to that of the above mentioned agencies.

Data reliability is based on the reliability of the mapping boundaries and the attributes that are associated with them (attribute accuracy ANZLIC). Data reliability can be defined by the density of the ground truthing which may range from sparse to comprehensive.

Not all jurisdictions meet the minimum or core elements set out by AUSLIG or ERIN, however, a category system could be put into place to measure quality and reliability of each data source as follows:

- Quality of Data (category 1 – 4; range of best practice; category 5 fully meeting standards)
- Scale of Data Reliability (category 1 – 5; sparse to category 5 comprehensive ground truthing)

When tabular data needs to be produced such as in the report for Action 6 (status / coverage of ecosystem / ecosystem component mapping), a table similar to Table 2.2 should be produced.

Table 2.2: Ecosystem Mapping Coverage Data Quality and Reliability *(Example Only)*

Bioregion	Area (sq km)	% Mapped	Range of ecosystem components mapped	Quality	Reliability	Comments
Example bioregion	32,198	3.4	Substrate type	4	3	Source A
			Bathymetry	5	4	Source B
			Benthic habitat type	3	3	Source C

3. Overview of Mapping Coverage

3.1 Summary of Jurisdiction Coverage

Table 3.1 presents an aggregated summary of coverage of marine benthic habitat mapping for each jurisdiction.

Table 3.1: Summary Table of Coverage of Benthic Habitat Mapping by Jurisdiction

Jurisdiction	Jurisdictions Bioregion Area (sq km)	Area of mapping in Bioregion (sq km)	% coverage of mapping in Bioregion
New South Wales	8,574	1,896	22.1
Northern Territory	93,931	2,050	2.2
Queensland	104,811	5,764	5.5
South Australia	60,293	20,059	33.3
Tasmania	19,397	3,725	19.2
Victoria	10,050	6,151	61.2
Western Australia	117,744	16,393	13.9
Commonwealth (excl. GBRMPA)[A]	1,585,046	B	B
GBRMPA	211,849	211,849	100.0
Total	2,211695	267,887	12.1

Notes
A – Includes Commonwealth waters between State waters boundary and outer limit of IMCRA bioregion mapping
B – Minimal Benthic Habitat Mapping has occurred in Commonwealth Waters within IMCRA bioregions (apart from GBRMPA)

3.2 Overview of Mapping Coverage among Jurisdictions

Any discussion of the comparative progress of benthic habitat mapping by jurisdiction is limited by the difficulties in comparing mapping collected for different purposes, as well as at different scales and with different levels of reliability and quality. However, with cross reference to the data sources (refer Report for Action 8 and below) a broad picture emerges of the strengths and limitations of the benthic habitat mapping outputs and coverage among jurisdictions, and consequently their application for strategic planning of a CAR system of MPAs.

An overview of the issues affecting the coverage, quality and reliability of the mapping data of the jurisdictions is provided below to provide context for the interpretation of Table 3.1. It is noted that 100% mapping coverage is unlikely to be an aim of jurisdictions, however, a low figure would be a concern as it would make justification of MPAs on the basis of comprehensiveness difficult.

New South Wales

New South Wales has set in place a process to progress through each IMCRA region for evaluation of MPAs. This process is the drive behind mapping and collation of mapping at the 1:100,000 scale or better. To date, the Tweed Moreton IMCRA region has been mapped and the Manning Shelf is next in the process.

NSW Marine Parks Authority (via NSW Fisheries and NPWS) has undertaken an 'ecosystem' based mapping approach for the Tweed Moreton bioregion (south of Queensland border). The mapping and attribute classification approach is described by Marine Parks Authority (in prep) and involves the use of existing physical datasets for the development of marine physiographic features and the development of a micro-scale regionalisation approach using available biodiversity datasets. The resulting micro scale bioregions are regarded as being at an 'ecosystem' scale.

The hierarchy applied is consistent with a broad hierarchy intended for general application at a range of scales provided by NSW Fisheries as a basis for future mapping for strategic planning of MPAs in other bioregions. The Manning Bioregion is considered a high priority for future strategic mapping.

Northern Territory

The meso-scale bioregionalisation process PWCNT (in prep) pulls together much of the available relevant environmental datasets, together with a multivariate analysis of biological factors including coral, fish and mangrove distribution.

At a local scale several relevant ecosystem component mapping datasets for mangroves, corals and seagrasses have been collected including: Brocklehurst and Edmeades (1996); Wolstenholme et al (1997); Poiner et al (1987). A Coastal Resource Atlas of the major port areas is also held by the DLPE.

There is little ground truthed mapping of benthic habitat types throughout the Territory other than datasets for Darwin Harbour and the Gulf of Carpentaria, and benthic / sediment sampling in Beagle Gulf. Turbidity, difficult access, marine hazards and relative lack of comprehensive baseline physiographic data hinder the application of conventional ecosystem mapping techniques. Alternative mapping techniques are currently being developed.

Benthic Habitat Mapping has occurred and other types of mapping exist, mainly oceanographic and sediment / epibenthic sampling in Beagle Gulf in relation to a proposed MPA (PWCNT in prep).

Queensland (excluding GBRMP)

Considerable mapping effort coordination has occurred between Queensland Department of Primary Industry, Queensland Parks and Wildlife Service and GBRMPA. Broad scale intertidal and nearshore habitat type mapping has been undertaken, through QDPI of some 70 – 80% of the mainland coastline. Mapping of offshore benthic habitats is being undertaken by Coles et al (1992b) as well as a range of mapping and point data sets reported under GBRMPA and AIMS in the Action 8 Report. In particular, the long term monitoring cross shelf transects include survey of seagrass and benthic epifauna.

Queensland Parks and Wildlife Service is currently finalising projects to map and classify the shoreline (intertidal zone) of the mainland coast, continental islands and estuaries.

South Australia

The biounit classification in South Australia was based largely upon existing biophysical information gathered as part of South Australia's contribution to the IMCRA planning process, complemented by:

- Data and knowledge provided over several years by an inter-agency MPA Working Group; and
- State-wide benthic survey data, gathered during the Commonwealth funded Benthic Surveys Program in South Australia.

The biounit classification reflects the variety of geomorphological, geological, oceanographic and major biotic / ecological features within each region. Marine habitats of offshore areas beyond 30m to 50m have not been comprehensively mapped or ground truthed with respect to benthic marine habitats.

Tasmania

Strategic mapping and survey for the purpose of establishing a CAR system of marine protected areas in Tasmania has occurred at two broad scales. Surveys of reef communities and specific habitat and community mapping of small MPAs have occurred at scales sufficient for management and monitoring (1:25,000 and below). Strategic scale mapping and sampling of nearshore benthic habitats has occurred at 1;100,000 scale. However, this mapping has not yet been linked with parallel biodiversity survey, at habitats other than reefs, to provide a basis for bioregionalisation at sub-IMCRA scales.

Consultation with relevant Tasmanian agencies also indicates difficulties in establishing a broad coastal resource baseline, especially given the variable quality and coverage of coastal aerial photography. Offshore benthic habitats beyond 30m - 50m have not been comprehensively mapped or field truthed.

Victoria

In Victoria, marine 'ecosystem' mapping is conducted on both a strategic and management basis. The scale of mapping for both spatial and attribute detail is therefore dependent on the purpose for which it is required and resources available. All the attributes can be represented at different spatial scales, but this is dependent on the resolution and availability of attribute information from one area to the next.

The mapping summarised in Table 3.1 is primarily the identification of marine habitat classes based on sediment sampling, seagrass and reef/algal community sampling coordinated by the Department of Natural Resources and Environment. The classification and hierarchy of mapped attributes is described in the Report for Action 8.

Western Australia

Broad habitat mapping coverage of WA waters is divided into the temperate waters nearshore benthic habitat mapping dataset (south of Perth) and a collection of datasets for specific areas elsewhere (ie Ningaloo Reef).

CALM reports that initial broad stratification using satellite images and rectified aerial photos is conducted and, subsequently, representative areas and areas of interest are identified for field surveys. A field survey is conducted to confirm the biological content/identity of the habitat classes by direct observation in shallow waters/coasts, and by spot dives and/or video/jump camera in deeper waters. These sampling approaches have been involved in the Ningaloo Marine Park where approximately 600 spot surveys were undertaken over an area extending over 100 km of coastline. Field confirmation from field trips is broad (for the purpose of validating mapping classes and identity), primarily to confirm identity and spatial location.

Commonwealth of Australia (excluding GBRMP)

In addition to the benthic habitat mapping extending beyond state waters reported in Table 2.1, other types of mapping have been undertaken in particular areas of Commonwealth waters both within the IMCRA bioregions and the EEZ. This data has been collected by CSIRO or derived from datasets of other agencies such as AGSO. Ecosystem component mapping has been undertaken in Commonwealth waters (at varying scales and of different attributes) by CSIRO and EA in specific areas nominated as candidates for Commonwealth and Commonwealth/State MPAs. Areas mapped within IMCRA bioregions include:

- Tasmanian Seamounts (including large scale bathymetry from AGSO, video study for benthic habitat characterisation and the identification of species assemblages, and grab samples of substrate have also been taken)

- Great Australian Bight Marine Park Commonwealth Waters (including nearshore marine mammal distribution and video trawls and nearshore bottom sediment grabs)
- Monte Bello Islands (GIS mapping pilot project using data sourced from AGSO, CSIRO and the North West Shelf Study)
- Cartier, Mermaid and Ashmore Reefs (including large scale AGSO derived bathymetry and small scale hand drawn maps of marine habitat types (emergent areas, deep flat reef, submerged sand and lagoon) and collection of species distribution data)
- Jervis Bay (1:4,000 custodian: using data sourced by DoD / CSIRO)

Commonwealth waters mapped outside IMCRA bioregions outer boundary include waters surrounding or included within:

- Lord Howe Island
- Heard and McDonald Islands
- Macquarie Island / Macquarie Ridge (including video survey of benthic habitat and side-scan sonar mapping concentrating on determining whether benthic habitats differed north and south of the Ridge, to determine whether the proposed MPA would include sufficiently representative habitats)
- Christmas Island
- Torres Strait Treaty Zone (via CSIRO)

The objectives of these Commonwealth mapping and survey projects has included mapping for MPA management and monitoring as well as strategic planning for MPA identification and zoning. As a result mapping scales and attributes mapped are variable among projects.

In Commonwealth waters no systematic and broadscale process of mapping and sampling offshore marine biodiversity has been undertaken with the aim of establishing a representative system of MPAs in Commonwealth waters. Commonwealth mapping priorities have historically followed other driving factors, however, under the Oceans Policy a program of broadscale surveys has commenced.

Great Barrier Reef Marine Park Authority (GBRMPA)

A large number of mapping projects have taken place within the Park. The entire Park has been mapped, with base maps at a nominal scale of 1:250,000. The Authority has mapping below the IMCRA meso-scale level across the entire Park in regards to the evaluation of MPAs. The Authority is looking at finer scale mapping to derive new boundaries for highly protected zones within the Park.

Existing data sets used as the basis for the GBR sub-IMCRA bioregionalisations were: reef fish, soft corals, hard coral, reef biota, macroalgae, seagrass, reef geomorphology, bathymetry, mean tidal range, and broad scale currents. Numerical analysis - classification and regression tree (CART) and multiple regression tree analysis (MRT) were conducted on these datasets and formed the basis upon which the reefal and inter-reefal bioregions were drawn by workshops of experts.

Sub-IMCRA bioregions were the ecological unit mapped based upon:

- Mapped distributions of taxa, abundance and patterns of diversity
- Distributions of physical habitat descriptors such as sediment type, grainsize, bathymetry, currents, etc
- Reef geomorphology
- Mapped distributions of critical habitats and sites for migration, spawning, nesting
- Mapped distributions of natural and anthropogenic threats

- General knowledge of the GBR marine ecosystem

The reefal and inter-reefal bioregionalisations have 31 and 34 separate regions respectively. These (sub-IMCRA) 'bioregions' were defined on the basis of their biophysical characteristics. The biological characteristics found within a sub-IMCRA bioregion were considered less heterogeneous within the bioregion than compared to surrounding bioregions.

The sub-IMCRA bioregions were determined using a GIS projection of the Great Barrier Reef environs (showing bathymetry, sedimentology, reefs etc) displayed on an overlay in a delphic workshop context. The respective reef and inter-reef experts then agreed on the locations of the boundaries of the sub-IMCRA bioregions. From the overlay of the projected GIS coverage, polygons defining the sub-IMCRA bioregions were digitised. The error in the geographical location of the overlayed boundary lines was of less import than the category of the sub-IMCRA bioregions that the line delineated. The error in boundary lines reflected the amount of information available to determine the position of the line and the categories it represented. In particular, it was important to discern whether this line indicated a distinct sub-IMCRA bioregion difference or a subtle one and whether the sub-IMCRA bioregions it delineated were heterogenous due to geomorphological, biological or other parameters.

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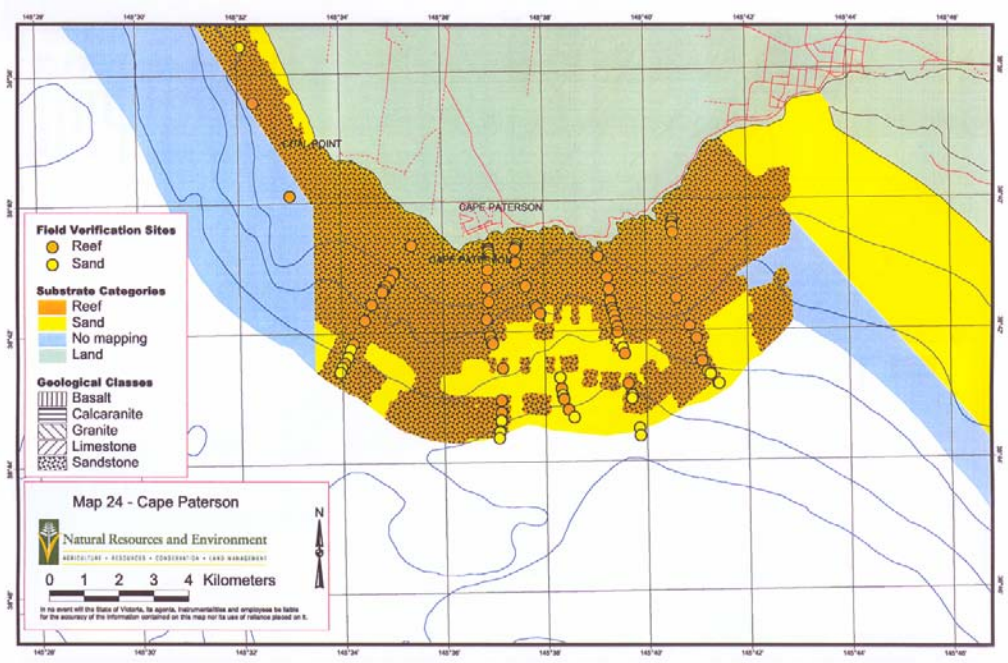
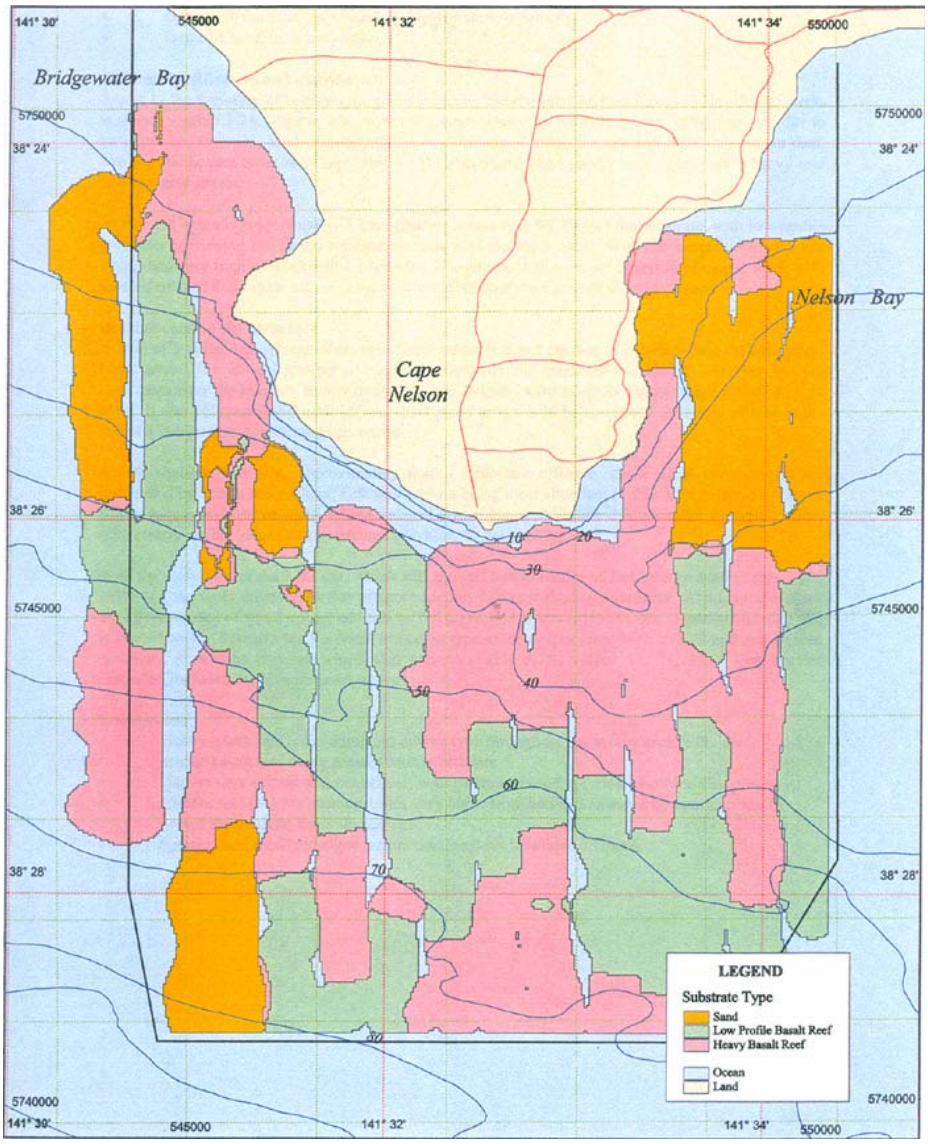
Appendix A

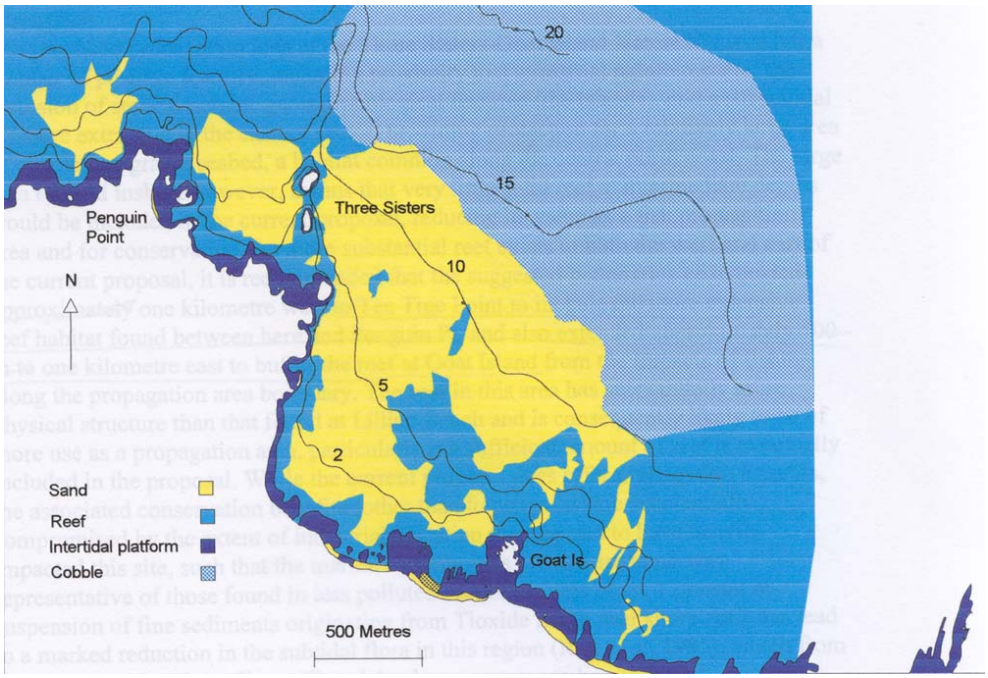
Examples of existing mapping at sub-IMCRA scales

Victoria Mapping – Top map (Ferns & Hough 1999) / Bottom map (Roob,Blake & Parry 1999)



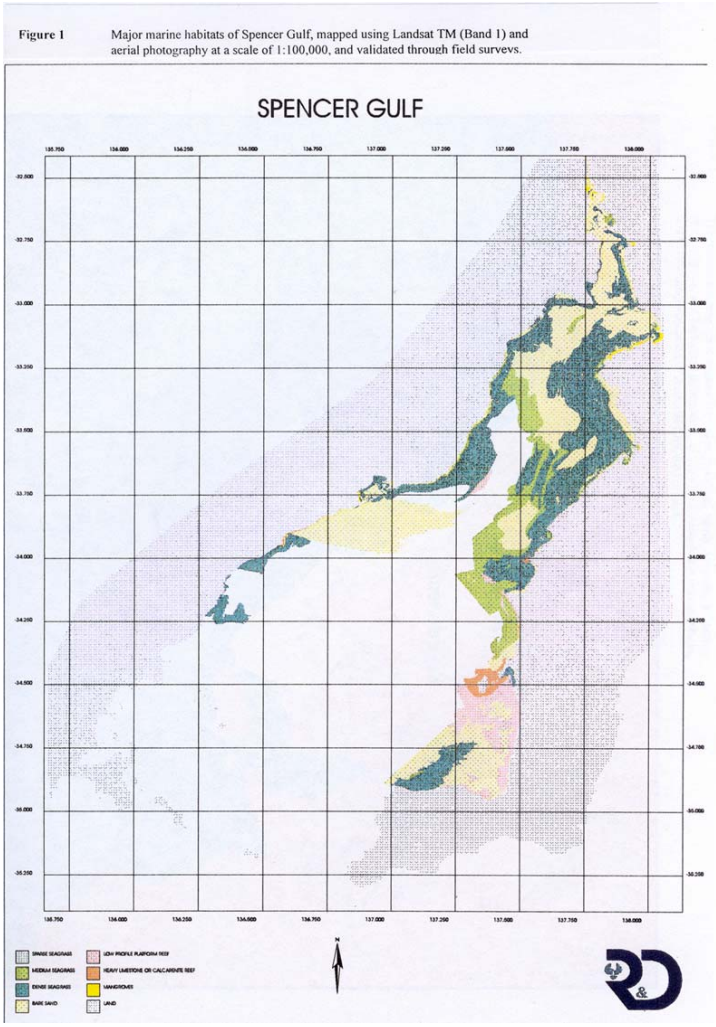


Tasmania Mapping – Barrett & Wilcox 1999

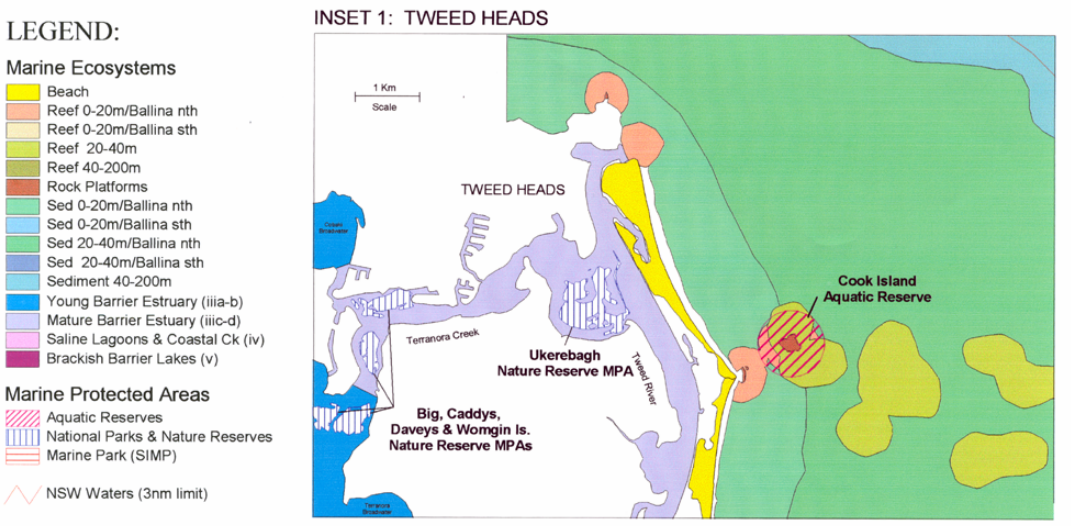


South Australia Mapping – in Edyvane & Baker 1996

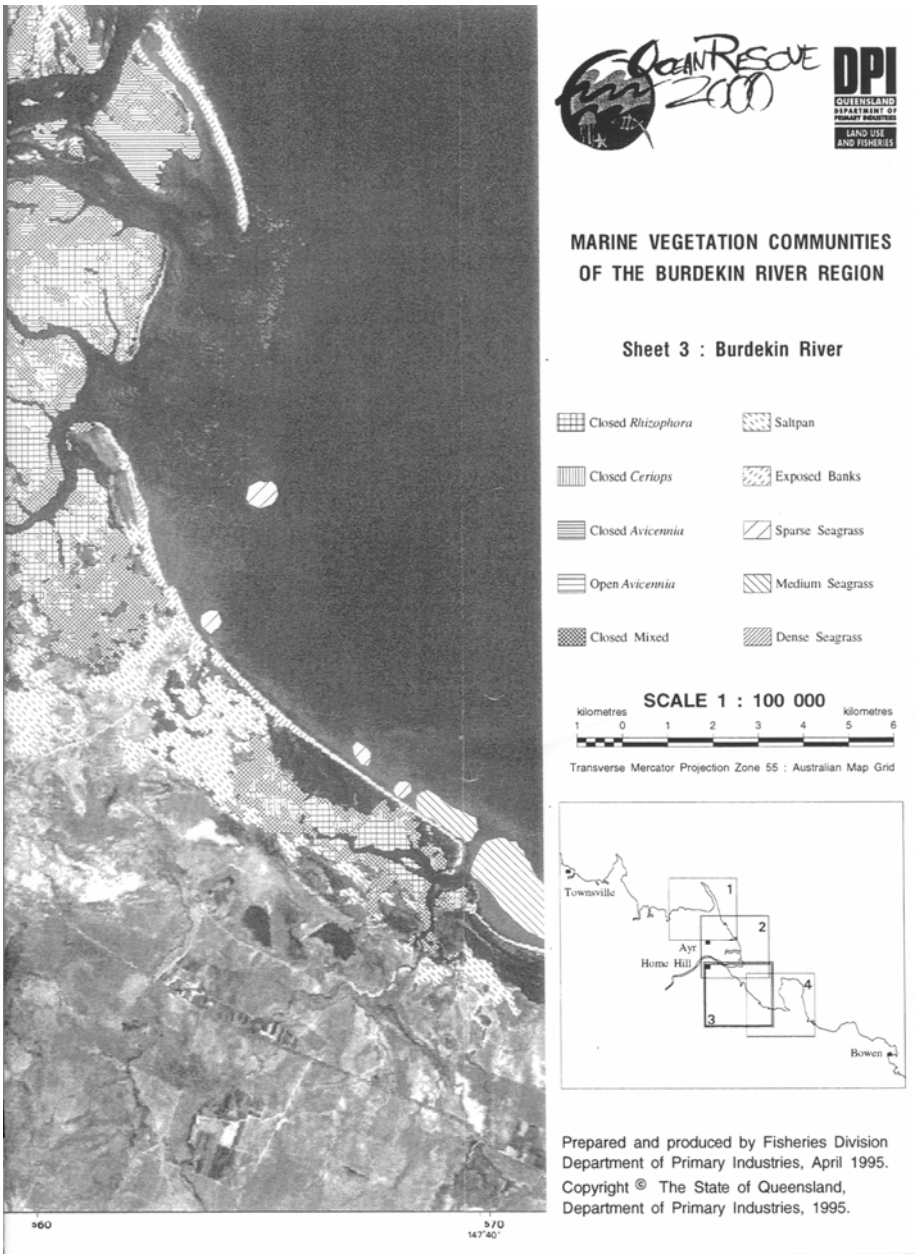
The following map is an example of CSIRO's remote mapping (undertaken by CSIRO as a collaborative project during SARDI's SA Benthic Survey Program)



New South Wales Mapping – Marine Parks Authority NSW 1999

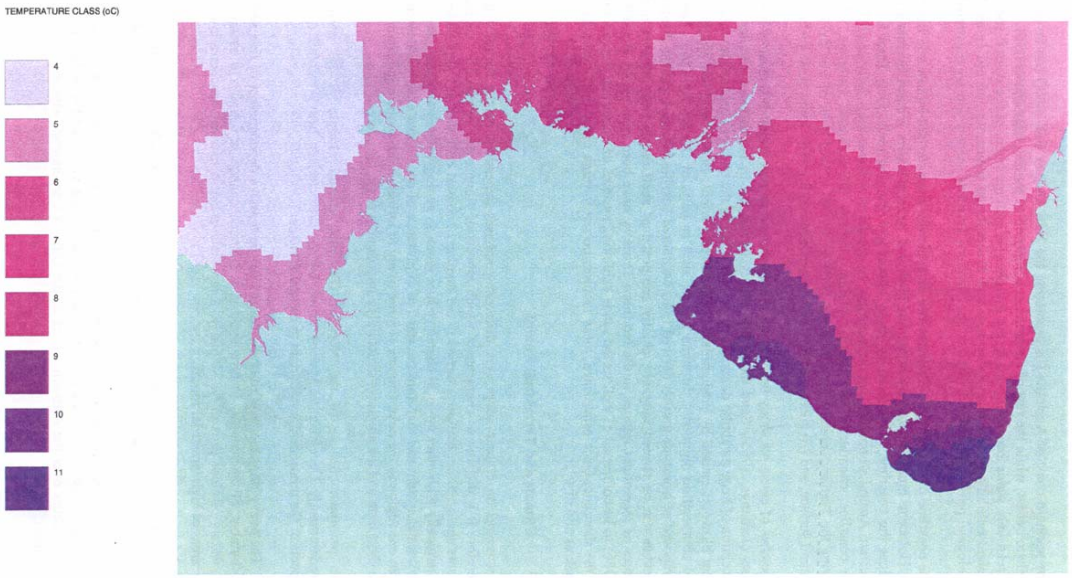


Queensland Mapping – Danaher 1995



Northern Territory – Ferns 1999

Fig.4. Annual sea surface temperature ranges for coastal waters surrounding the Northern Territory
(Original data courtesy CSIRO Division of Oceanography)



Commonwealth Mapping – Environment Australia 1999

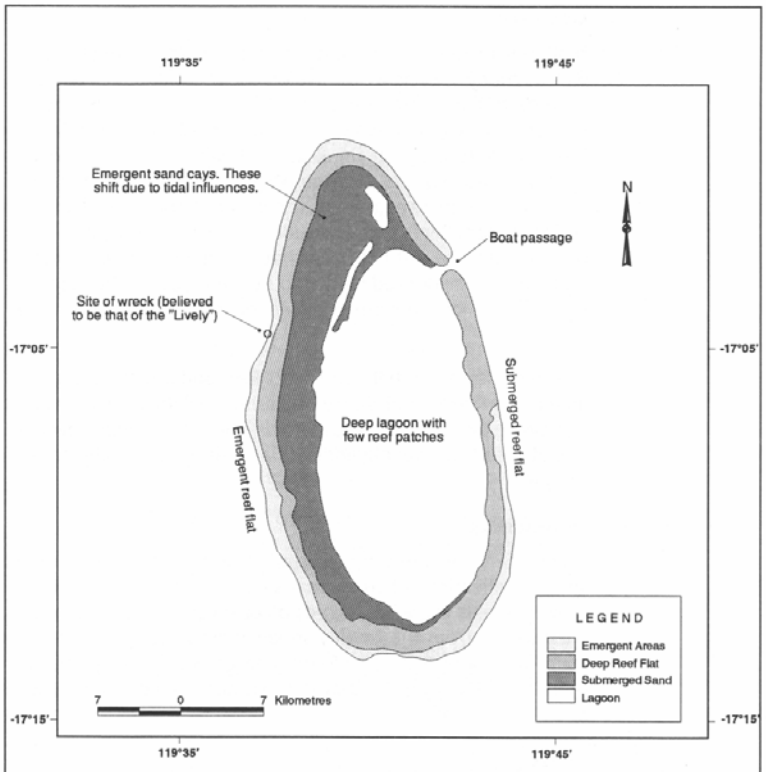


Figure 4: Mermaid Reef Marine National Nature Reserve - Marine Habitat Types

SOURCES:

Done,T.J., Williams,D.McB., Speare,P., Turak,E., Davidson,J., DeVantier,L.M., Newman,S.J., & Hutchins,J.B. (1994) "Surveys of Coral Fish and Communities at Scott Reef and Rowley Shoals." Australian Institue of Marine Sciences, Townsville, Australia.

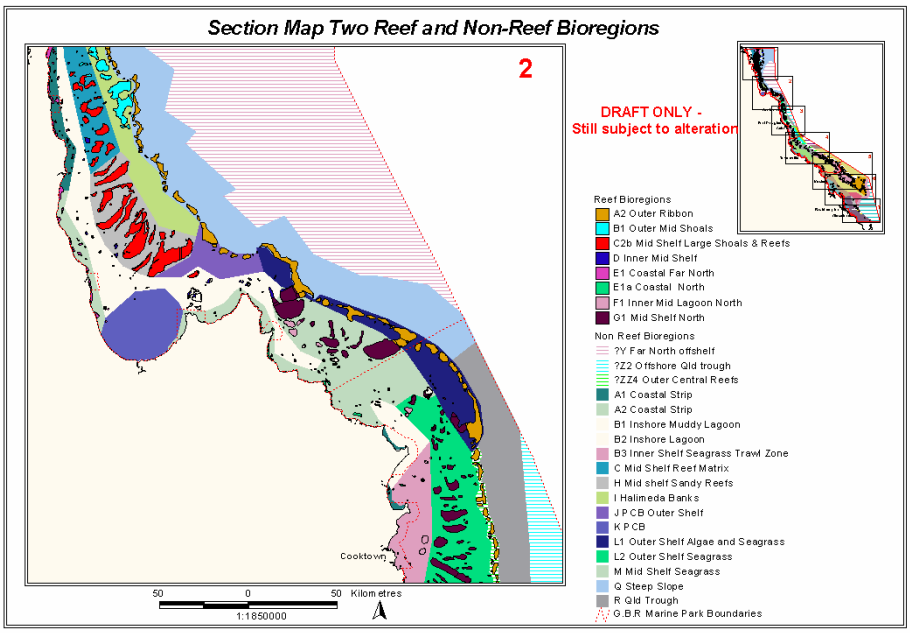
Produced by Environmental Resource Information Network (ERIN) Environment Australia Commonwealth of Australia, Canberra.

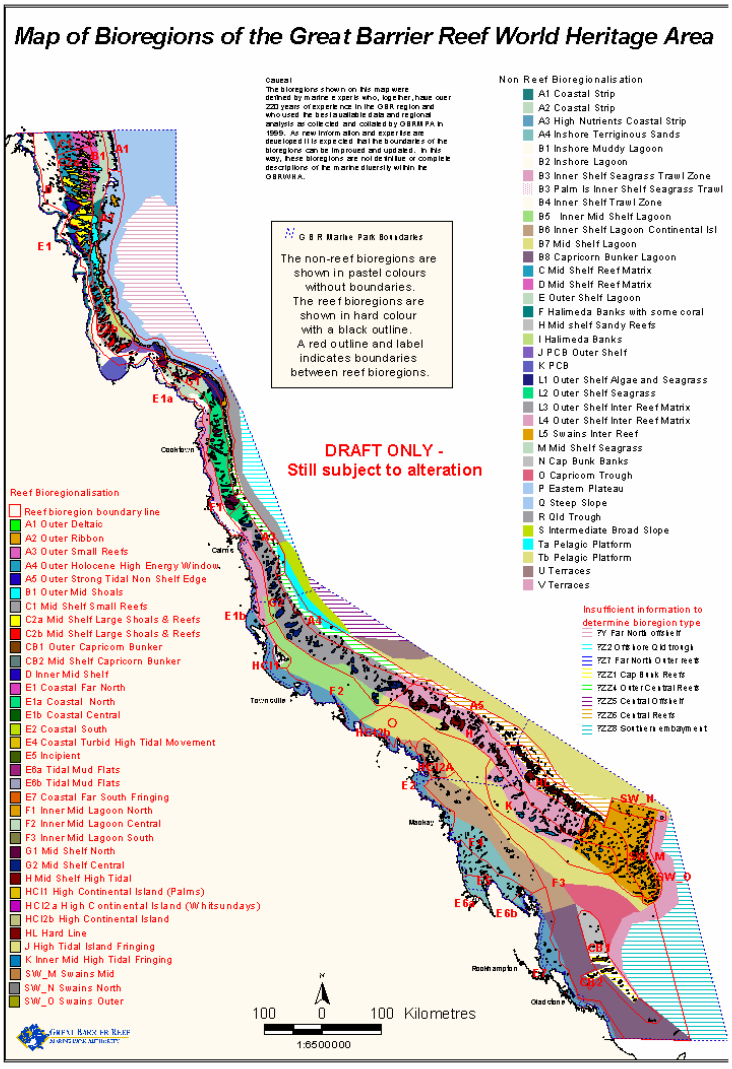
Projection: Geographic
Datum: WGS1984

Caveat: Data are assumed to be correct as received from the data suppliers.

Environment Australia
Department of the Environment and Heritage

GBRMPA – Maps are Draft Only (GBRMPA)





Appendix B

Study Brief

INITIAL ASSESSMENTS OF ECOSYSTEM MAPPING, VULNERABLE ECOSYSTEMS AND NATIONAL PRIOIRITIES FOR THE NRSMPA (Incorporating Threatening Processes Analysis)

1.0 BACKGROUND

1.1 Strategic Plan of Action for the NRSMPA

In July 1999, ANZECC endorsed the *Strategic Plan of Action for the National Representative System of Marine Protected Areas*: *a guide for action by Australian governments*. The Strategic Plan was developed cooperatively by all relevant marine management agencies in each State, the Northern Territory and the Commonwealth, through the ANZECC Task Force on Marine Protected Areas (TFMPA).

The primary goal of the NRSMPA is to establish and manage a comprehensive, adequate and representative system of marine protected areas (MPAs) 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 NRSMPA has secondary goals to: promote integrated ecosystem management; manage human activities and to provide, among other things, for the needs of species and ecological communities; and for the recreational, aesthetic, cultural and economic needs of indigenous and non-indigenous people, where these are compatible with the primary goal.

The Strategic Plan lists 34 actions to be undertaken by the Commonwealth, the States and the Northern Territory to advance marine protected area development in Australia. TFMPA have agreed to a process involving the use of small action teams, comprising representatives from each of the jurisdictions involved, to progress each of the actions in the Strategic Plan. The staged implementation of these actions will progressively inform the process of identifying candidate MPAs.

The Strategic Plan complements the *Interim Marine and Coastal Regionalisation for Australia (IMCRA)* and the *Guidelines for Establishing the National Representative System of Marine Protected Areas*, which were endorsed by ANZECC in June and December 1998, respectively.

1.2 Comprehensiveness, Adequacy and Representativeness (CAR)

The Strategic Plan defines comprehensiveness, adequacy and representativeness (or CAR) as the three principles that underpin the establishment, planning, management and performance assessment of MPAs in the NRSMPA.

- Comprehensiveness: The NRSMPA will include the full range of ecosystems recognised at an appropriate scale within and across each bioregion.
- Adequacy: The NRSMPA will have the required level of reservation to ensure the ecological viability and integrity of populations, species and communities.
- Representativeness: Those marine areas that are selected for inclusion in MPAs should reasonably reflect the biotic diversity of the marine ecosystems from which they derive. *(Source: ANZECC TFMPA 1999)*

Scale is an important consideration for the application of the CAR principles. For the NRSMPA, the agreed hierarchy of biological organisms, against which the principles are applied, is:

bioregion

ecosystem

habitat

community/population

individual/species.

For the NRSMPA comprehensiveness and adequacy are understood and applied at the scales of bioregions, ecosystems and habitats. Representativeness is applied at the finer scales of communities and individuals/species.

The CAR principles underpin the implementation of all actions under the Strategic Plan. As such, it is important that all parties understand and use the principles consistently. A draft report (in progress) entitled *Understanding and Applying the Principles of Comprehensiveness, Adequacy and Representativeness for the NRSMPA* is currently being prepared through TFMPA to facilitate national agreement to applying the principles in a consistent fashion.

2.0 PROJECT OVERVIEW

This project relates to four key Actions from the Strategic Plan of Action for the NRSMPA (pages 6-7):

Action 4: Vulnerable ecosystems
Assessments and mapping of rare, vulnerable and endangered marine ecosystems will be carried out, in association with an analysis of threatening processes.

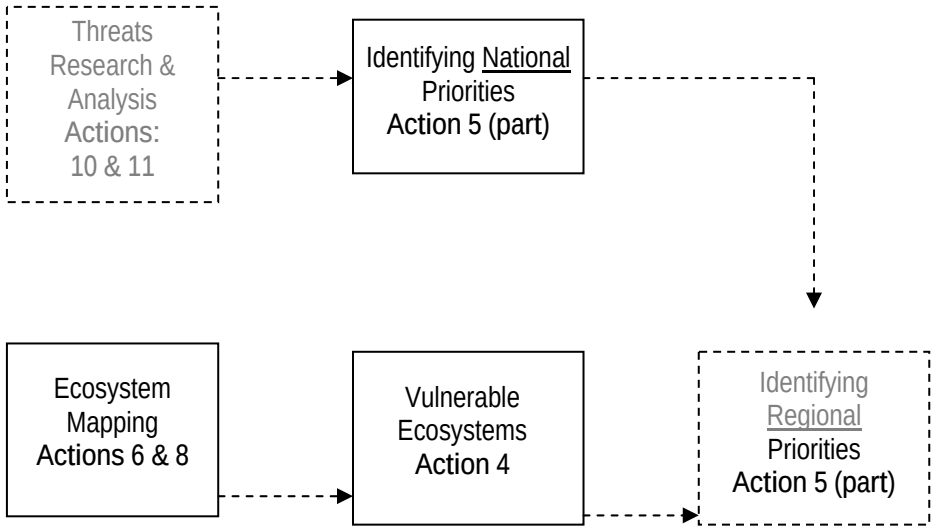
*Action 5: Identifying priorities for candidate MPAs**
Identify national and regional candidate areas for establishing MPAs based on information from Actions 1-4 and 10-11.

Action 6: Ecosystem mapping
Continue ecosystem mapping and biodiversity assessment work. This data will also be used in future refinement of IMCRA.

Action 8: Review methods for ecosystem mapping
Review methods for mapping ecosystems for the NRSMPA and develop an operational definition of ecosystem.

Action 5 will incorporate the results of the work on Threats Analysis and Research (Action 10) being undertaken separately by Environment Australia (Attachment C).

The relationship between these actions is represented in the diagram below.



3.0 PROJECT TASKS

3.1 Task 1: Review Methods for Describing and Mapping Ecosystem Components for the NRSMPA (Action 8)

There is no agreed national approach to ecosystem mapping in the Australian marine environment. Mapping methods used, and the interpretation of what constitutes an 'ecosystem' at particular mapping scales, varies quite considerably among jurisdictions. However, habitats are the most commonly used unit to map ecosystem components.

Given the differences in mapping scales and methodologies, a review of this information is vital for national understanding and comparison and for the development of an agreed approach and common standards for ecosystem mapping. It will also assist in assessing the comprehensiveness, adequacy and representativeness of the NRSMPA.

3.1.1 Objectives

- Review ecosystem mapping methods employed by jurisdictions, including mapping units.
- Review relevant ecosystem mapping methods, including mapping units, employed by other scientific agencies (eg. AIMS, CSIRO, AGSO and Universities).
- Establish suitable minimum standards and scales of mapping to define 'ecosystems', 'habitats' and 'communities' for the NRSMPA.

3.1.2 Scope

In consultation with Commonwealth, State and Territory agencies:

- Review ecosystem mapping methods and standards (sub-IMCRA scale) employed by each jurisdiction.
- Review relevant ecosystem mapping methods and standards employed by other key scientific agencies (eg. AIMS, CSIRO, AGSO and Universities).
- Review mapping scales and hierarchies used by each jurisdiction to define 'ecosystem', 'habitat' and 'community'.
- Propose suitable minimum standards and scales of mapping to define 'ecosystem', 'habitat', and 'community' for the NRSMPA (inshore and offshore waters).

3.1.3 Outputs:

A consolidated report of ecosystem mapping methods and standards for each jurisdiction/key agency, including a description of:
mapping scales and hierarchies used to define 'ecosystem', 'habitat', and 'community';
the types of ecosystem components mapped;
data, attributes and descriptions;
data collection methods, including accuracy, precision and resolution measures; and
methods for analysis, interpretation and presentation of data (eg. GIS).
Recommendations to guide the development of an agreed national approach to ecosystem mapping under the NRSMPA.
Draft minimum standards and scales for mapping to define 'ecosystem', 'habitat', and 'community' for the NRSMPA.

3.2 Task 2: Status of 'Ecosystem' Mapping for the NRSMPA (Action 6)

Ecosystems form the basis of planning and management for the NRSMPA. Many jurisdictions have made considerable advances in collecting, analysing and mapping the marine environment, generally at the 1:100,000 scale. Most map habitats. In some instances (eg. South Australia), IMCRA regions are divided into sub-units (eg. biounits). A review of ecosystem mapping in each jurisdiction is required to benchmark progress for the NRSMPA.

3.2.1 Objective

Review each jurisdiction's progress towards mapping ecosystem components for the NRSMPA.

3.2.2 Scope

In consultation with Commonwealth, State and Territory agencies:

- Review the progress each jurisdiction has made toward identifying and mapping marine ecosystem components at sub-IMCRA scales.
- Establish quantitative measures of progress in ecosystem mapping, expressed as:

a proportion of the jurisdiction's waters mapped at a given scale; and
a proportion of each IMCRA region mapped at a given scale.

3.2.3 Outputs

A report providing an overview of the progress made by each jurisdiction on mapping ecosystem components, including examples of existing map products.

3.3 Task 3: 'Vulnerable' Ecosystems (Action 4)

The principle of representativeness implicitly requires that the MPA system also include those marine ecosystems that are rare, vulnerable or endangered.

3.3.1 Objectives

- Review progress made by jurisdictions to identify rare, vulnerable and endangered marine ecosystems.
- Develop and apply an interim classification system for rare, vulnerable and endangered marine ecosystems under the NSRMPA.

3.3.2 Scope

In consultation with Commonwealth, State and Territory agencies:

- Review and document procedures used and progress made by jurisdictions to classify and map rare, vulnerable and endangered marine ecosystems.
- Develop an interim classification system for rare, vulnerable and endangered marine ecosystems under the NSRMPA, including draft criteria for its application.
- Using the above criteria, determine the conservation status of marine ecosystems in 2-3 jurisdictions yet to undertake this task.

3.3.3 Outputs

- A report outlining the procedures used, and the progress made, by jurisdictions to identify rare, vulnerable and endangered marine ecosystems, including for each jurisdiction:

a list of ecosystems which have undergone conservation assessment;
GIS coverage (mapping) of rare, vulnerable and endangered ecosystems.

- An interim conservation classification system for marine ecosystems under the NSRMPA, including draft criteria for its application.
- For 2-3 jurisdictions, lists and GIS coverage of ecosystems which have undergone a conservation assessment using the newly developed criteria.

3.4 Task 4: Identifying Priorities for Candidate MPAs (Action 5)

This task will assist in identifying and setting comprehensive, adequate and representative priorities for MPAs. It will also contribute to the performance assessment of the NRSMPA.

3.4.1 Objective

- Document current information on MPA declarations, zonings and proposals for each jurisdiction.
- Identify an initial set of national priority IMCRA regions for establishing MPAs.

3.4.2 Scope

- In consultation with jurisdictions, collate and document current information on MPA declarations, zonings and proposals (where available).
- Establish percentage coverage of MPAs within IMCRA meso-scale regions, including an update of Map 2 of the Strategic Plan, using:

spatial data on declared MPAs; and
spatial data on declared plus proposed MPAs.

Note: The calculations of percentage coverage of MPAs within IMCRA regions will be affected by the accuracy and treatment of spatial data. Technical advice in this area can be provided by ERIN, the Environmental Resources Information Network, if required.

- Identify and map an initial set of national priority IMCRA regions based on the integration of:

percentage coverage of MPAs within IMCRA meso-scale regions; and
IMCRA level threatening process information (Action 10) to be provided by Environment Australia (refer Attachment C).

Note: Identifying regional (sub-IMCRA scale) priorities for establishing MPAs under Action 5 is not part of this consultancy.

- In consultation with jurisdictions, undertake a basic qualitative assessment of the contribution of existing MPAs to CAR.

3.4.3 Outputs

- An overview report of available information on MPA declarations, zonings and proposals for each jurisdiction.
- Tables and maps detailing percentage coverage of MPAs within IMCRA meso-scale regions for:

declared MPAs; and
declared plus proposed MPAs.

- A list and map of national priority IMCRA regions.
- An overview report providing a basic qualitative assessment of the contribution of existing MPAs to CAR.

Appendix C

Glossary & Acronyms

*Glossary

Adequacy The maintenance of the ecological viability and integrity of populations, species and Communities

ANZECC Australian and New Zealand Environment and Conservation Council, a Ministerial Council representing all jurisdictions

Baseline The territorial sea baseline is the line from which the seaward limits of Australia's maritime zones are measured

Bioregion An ecologically based regionalisation at a particular scale (ie IMCRA meso- to provincial scale)

Biodiversity The variety of life forms: the different plants, animals and micro-organisms, the genes they contain, and the ecosystems they form. It is usually considered at three levels: genetic diversity, species diversity and ecosystem diversity

CAR Reserve System A system of protected areas that address the comprehensiveness, adequacy and representativeness (CAR) of all its component ecosystems

CAPAD Collaborative Australian Protected Areas Dataset

Community An assemblage of species occupying a particular habitat or area

Comprehensiveness Includes the full range of ecosystems recognised at an appropriate scale within and across each bioregion

Condition The current state of ecosystems compared to what would be considered pristine

Conservation The protection, maintenance, management, sustainable use, restoration and enhancement of the natural environment

Ecosystem A dynamic complex of plant, animal and microorganism communities and their non-living environment interacting as a functional unit (Convention on Biological Diversity, 1992)

Endemic Restricted to a specific region or site

Ground truthing Site investigations to validate the mapping assumptions made using remote sensing

Habitat A specific type of environment inhabited either permanently or temporarily by organisms

IMCRA The Interim Marine and Coastal Regionalisation for Australia is an ecosystem based classification for marine and coastal environments. It provides ecologically based regionalisations at the mesoscale (100-1000km) and at a provincial scale (greater than 1000s km)

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 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 (IUCN 1994)

Physiographic Features Geomorphological elements of the landscape or seabed

Representativeness	Those marine areas that are selected for inclusion in reserves should reasonably reflect the biotic diversity of the marine ecosystems from which they derive
Remote Sensing	Use of satellite or aerial photographic imagery as a mapping tool
Side-scan Sonar	Transmission of short regular pulses of sound and receipt of echoes by a transducer pointing sideways from a survey vessel. Resulting echoes are digitised and recorded electronically.
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
Threatening Processes	The dominant limiting factors and constraints to the ongoing conservation of biodiversity
Viability	The likelihood of long-term survival of the example / population of the particular ecosystem or species under consideration

*Acronyms

AGSO	Australian Geological Survey Organisation
AIMS	Australian Institute of Marine Science
AODC	Australian Oceanographic Data Centre
AUSLIG	Australian Surveying and Land Information Centre
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZLIC	Australia New Zealand Land Information Council
CALM	Department of Conservation and Land Management (WA)
CAPAD	Collaborative Australian Protected Areas Dataset
CAR	Comprehensiveness, Adequacy and Representativeness
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DLPE	Department of Lands Planning and Environment (NT)
DoD	Department of Defence
EA	Environment Australia (Commonwealth Department of the Environment and Heritage)
ERIN	Environmental Resources Information Network
GBRMP	Great Barrier Reef Marine Park
GBRMPA	Great Barrier Reef Marine Park Authority
IMCRA	Interim Marine and Coastal Regionalisation for Australia
MPA	Marine Protected Area
NPWS	National Parks and Wildlife Service (NSW)
NRSMPA	National Representative System of Marine Protected Areas
PWCNT	Parks and Wildlife Commission of the Northern Territory
QDPI	Queensland Department of Primary Industry
QPWS	Queensland Parks and Wildlife Service
TAFI	Tasmanian Aquaculture and Fisheries Institute
TFMPA	Task Force on Marine Protected Areas

* Largely extracted from: Australian and New Zealand Environment and Conservation Council Task Force on Marine Protected Areas 1999, *Strategic Plan of Action for the National Representative System of Marine Protected Areas: A Guide for Action by Australian Governments*. Environment Australia, Canberra.

Appendix D

Contact List

Jurisdiction	People Consulted	Phone/Fax/Email
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Appendix E

Checklist Format

AGENCY CONSULTATION CHECKLIST

ACTION 8 – Review methods for describing mapping ecosystem components for the NRSMPA

- What ecological units are used as the basis for mapping (ie ecosystem, habitat, community)
- How are mapping units being defined in ecological terms
- What other mapping methods are being used by other agencies (CSIRO, AIMS, AGSO etc)
- Scale of map for which ecosystems are digitised (input and output)
- What tolerances are used in digitising and creating a boundary for an ecosystem. What is the accuracy of base/source maps and digitising?
- What information (metadata) is created for the digitised areas of ecosystems
- Does the jurisdiction following the ANZLIC Metadata Guidelines
  (Categories of Data, Description, Data Currency, Data Status, Access, Data Quality, Contact Information, Metadata Date, Comments)
- What are the projection and datum for data management used in the jurisdiction

ACTION 6 – Status of ecosystem mapping for NRSMPA

- Check mapping coverage of and within IMCRA regions
- What type and scale of mapping has occurred at different mapping scales
- Application of performance standards – is proportional coverage of jurisdiction / IMCRA region readily calculable or available

ACTION 4 – Vulnerable Ecosystems

- What procedures or criteria used to ID vulnerable etc ecosystems
- How are vulnerable etc ecosystems mapped
- Does the jurisdiction have GIS coverages of vulnerable etc ecosystems and what mapping standards were used
- Check suitability for candidate area for trial of methodology

ACTION 5 – Identifying Priorities for candidate MPAs

- Collect info on declarations, zonings, and proposals since CAPAD 1997
  (How many, is there spatial data and attributes, is data in a CAPAD format)
- Check coverage data within IMCRA regions
- Enquire agency priorities/criteria for candidate MPAs

- Discuss qualitative CAR assessment of jurisdictions MPAs