MARINE RESERVE IMPLEMENTATION:
Kimberley Region

BIOPHYSICAL RESOURCE ASSESSMENT OF THE CANNING COAST, WA

including

ROEBUCK BAY, LAGRANGE BAY AND EIGHTY MILE BEACH

Data Report: MRI/CAN,EMB/RBL,EMB-66/2005

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EXECUTIVE SUMMARY

The objective of the project is to assist with the future planning of marine conservation reserves in the Canning coast (West Kimberley) region. It is specifically concerned with the information requirements of the conservation planning process and examines the extent to which information needs are met. As these needs are dynamic, there is a fundamental requirement to manage the different types of information and ensure they are readily accessible and in a format that enables expedient application to the different planning stages (eg. broad scale assessment, marine conservation reserve planning). In Western Australia, information gathered to support marine conservation planning is typically managed through the delivery of four fundamentally different products:

- a spatial framework for marine conservation planning;
- a research and monitoring projects database;
- a reference database; and
- a contacts database.

This project makes a significant contribution towards the delivery of these products to facilitate the effective use of information in future marine conservation planning processes and natural resource management in the Canning coast. Effort is primarily directed towards the development of a spatial framework as no previous attempt has been made to capture spatial information on the biodiversity of the Canning coast region. This report presents the approach taken to develop these products, with the products themselves provided on an accompanying CD.

While more than 100 spatial datasets have been identified, the utility of these datasets for marine conservation planning is often limited by their incomplete coverage, broad scale of resolution (too uniform over the region of interest), or simply that they were not intended to support marine planning decisions. Some clear gaps in knowledge remain, most notably for subtidal marine habitats and their associated biological communities. What is now required is a clear understanding of the timeframe for progressing marine conservation planning in the Canning coast as this will help to determine how best to move forward, ensure the most appropriate use of resources to address current gaps in knowledge and support the effective use of information for the selection of comprehensive, adequate and representative system of marine conservation reserves.

Due to resource constraints, the social information was not actively sourced. Therefore, as the capture of social datasets was largely opportunistic, an assessment of gaps is not meaningful at this stage.

CONTENTS

* * *

LIST OF FIGURES

* * *

LIST OF TABLES

* * *

1. General Introduction

In 1994, the Government of Western Australia unveiled a policy that provides the framework for the conservation and management of the State's marine environment. A major component of the policy is the establishment of a comprehensive and statewide system of marine conservation reserves (MCRs) to preserve representative and special marine ecosystems and to ensure that the various uses of MCRs are managed in an equitable, integrated and sustainable manner (Government of Western Australia 1994). The Western Australian marine reserve system contributes to Australia's National Representative System of Marine Protected Areas (NRSMPA). The NRSMPA is a key strategy to protect Australia's marine biological diversity and helps meet the Australian Government's obligations under several international conventions and agreements. The primary goal of the NRSMPA is "to establish and manage a comprehensive, adequate and representative system of 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" (Australian and New Zealand Environment and Conservation Council 1998).

Before an area can be included within the statewide marine parks and reserves system established under the *Conservation and Land Management Act 1984 (CALM Act)*, it is typically subject to a three-tiered system of assessment. The first tier is the broadest level of assessment and serves to inform where more detailed planning should proceed. It commenced in 1986 with the appointment of the Marine Parks and Reserves Selection Working Group (MPRSWG) to review the coast as a whole and to identify areas that have particular values for conservation, scientific, and public recreational purposes. This statewide assessment led to the preparation of a report which identifies areas considered by the MPRSWG to be worthy of reservation. The MPRSWG's recommendations were submitted to government for consideration in 1994 (Marine Parks and Reserves Selection Working Group 1994).

The second tier of assessment provides a more detailed review of a specific area/region of interest that is likely to be the focus of a formal planning process. It is conducted before the formal planning process is initiated and is generally referred to as the resource assessment phase. Here, the emphasis is on the preparation of information to facilitate the formal planning process of a proposed marine conservation reserve(s) with a focus on both the ecological and social values. This approach is consistent with the State Government's New Horizon policy commitment to ensure that "a comprehensive assessment of the area's biological and economic resources and social values is carried out" and contributes to the requirement for "extensive assessment, community consultation and management planning before a new conservation reserve is established" (Government of Western Australia 1994).

The third tier of assessment underpins the formal planning process governed by the legislative provisions of the *CALM Act 1984* for the declaration of marine reserves. It is primarily concerned with definition of boundaries for the proposed reserve and an assessment of the suitability of alternative reserve category and management zone options in view of the conservation values, community aspirations and patterns of human usage. The *CALM Act* provisions require the publication of a notice of intent specifying the boundaries of the proposed reserve, the release of an indicative management plan, periods of public comment, the provision of formal advice to the

Minister for the Environment and referral of the proposal to government Ministers for concurrence. The formal planning process includes implementation of a community consultation program to facilitate public input into the development of the marine conservation reserve proposal.

This aim of this project is to contribute to the second tier of assessment; the resource assessment phase for the planning and establishment of marine conservation reserve(s) in the Canning coast (West Kimberley) region. The planning region extends from Cape Leveque to Cape Keraudren and encompasses the Western Australian coastal waters of the Canning and Eighty Mile Beach IMCRA bioregions (Figure 1.1) (Interim Marine and Coastal Regionalisation for Australia Technical Group 1998).

Whereas previous marine resource assessments have typically focused on a specific area of interest that is likely to be the focus of a formal planning process, this project has adopted a different approach by scaling the assessment up to a regional level. The reasons for this approach are outlined in Chapter Two, which includes a brief review of the recommendations of the MPRSWG (Marine Parks and Reserves Selection Working Group 1994) and other conservation proposals relevant to the region. Our discussion highlights the significance of these findings in providing context for the second tier of assessment and for defining the objectives of this study in particular. Chapter Three presents a summary of the information requirements for the second-tiered phase of the planning process. It briefly reviews the published international literature on the information needs for marine conservation planning, followed by a summary of the information needs as documented in standards and procedures developed by the Department to support the formal phase of the planning process for the establishment of marine conservation reserves in Western Australia. Chapters Four to Seven present an outline of the approach taken to develop the four products that are the key outputs of this project and which represent a significant contribution towards the resource assessment phase. They are described as follows:

- A spatial framework for marine conservation planning;
- A research and monitoring database;
- A reference database; and
- A contacts database.

The products form an appendage to this report, with the first three products provided in a CD format to enable easy access to both government and community sectors. Access to the contacts database is restricted and is subject to the prior approval of the relevant individual before details can be released. Chapter Eight presents a closing review of the current state of knowledge as determined from the audit of spatial and non-spatial information, together with the report findings.

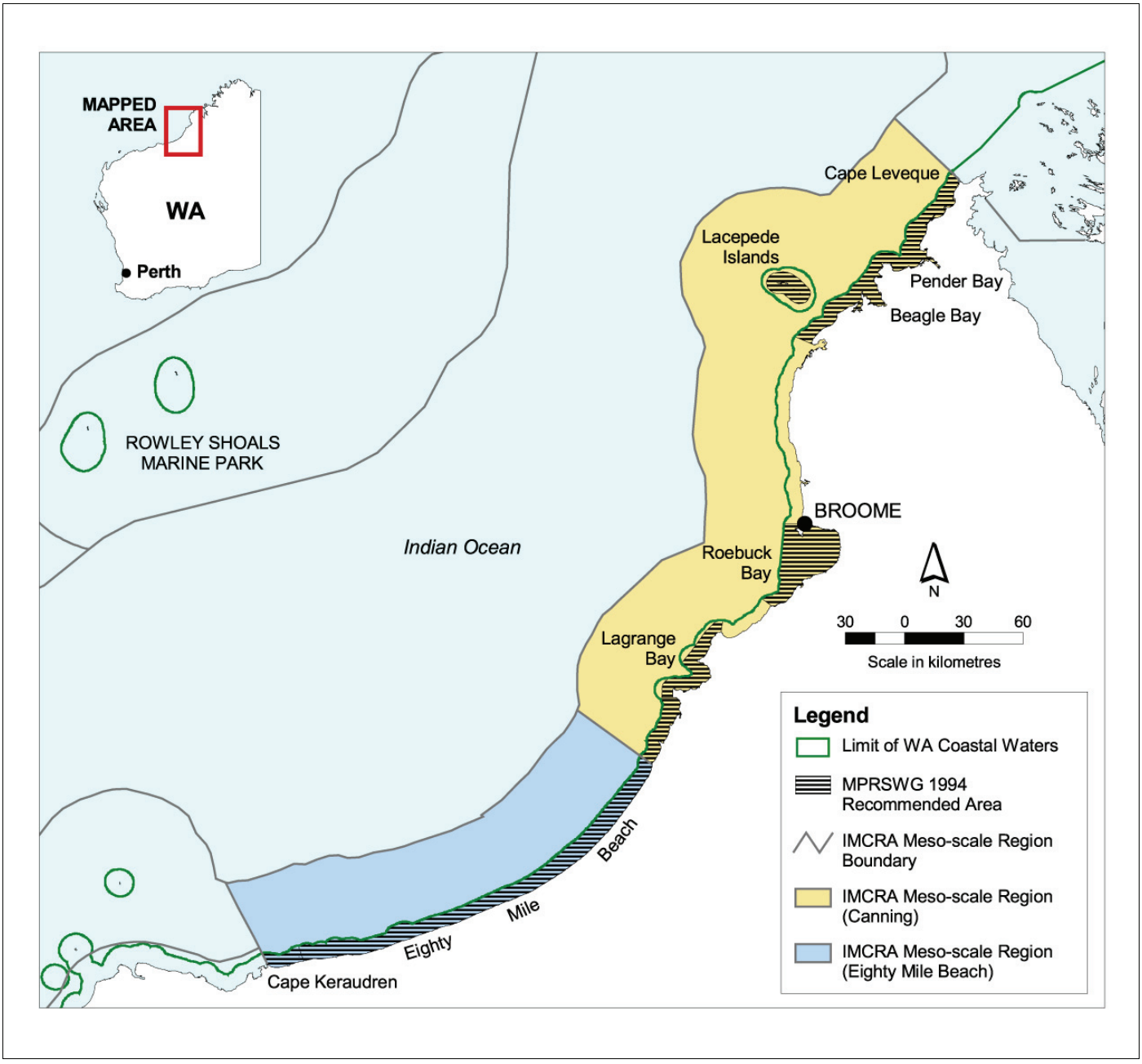


Figure 1.1. Map showing the Canning Coast, Western Australia, extending from Cape Leveque to Cape Keraudren and encompassing the WA state coastal waters.

2. Review of Past Recommendations

2.1. CONSERVATION PROPOSALS OF THE CANNING COAST

The Canning Coast, West Kimberley, is one of ten primary geomorphic coastal zones recognised along the Western Australia coast (Marine Parks and Reserves Selection Working Group 1994). It extends from Cape Leveque to Cape Keraudren and is considered by the MPRSWG in Part III of their assessment of the Canning and Pilbara coasts and the Rowley Shelf. The MPRSWG review led to five recommendations for the Canning Coast region (summarised in Table 2.1). Of these, one area (Roebuck Bay) has clear status as a candidate for reservation, a further three areas are noted for features that are representative of the area and an additional site (Lacapede Islands) is considered to warrant further assessment to determine its suitability as a marine reserve.

The MPRSWG's approach to selecting these areas was largely derived from a working paper prepared by the Council of Nature Conservation Ministers (CONCOM) on the development of a marine reserves system in Australia (Council of Nature Conservation Ministers 1985). The CONCOM approach supported a two-level classification of the Australian coastline as the basis for the selection of a representative system of marine conservation reserves, firstly on geographical classification of the regions and secondly, to select habitat or ecosystem types within the biogeographical units in order to achieve the best possible representativeness. On this basis, the Western Australian coast was classified into four sections: Kimberley; Canning-Pilbara; West Coast; and South Coast. The MPRSWG then applied a classification of coastal geomorphology and major distinctive coastal types as the second level of classification in the process, of which the Canning coast; extending from Cape Leveque to Cape Keraudren, appears as a distinct zone. Major marine ecosystems where known, were used to inform the selection of representative ecosystem types within these distinct coastal types. Consequently, the extent to which the MPRSWG recommended areas are comprehensive and representative is largely dependent on how well coastal geomorphology, coastal types and marine ecosystem types (of which there was limited knowledge) serve as surrogates for marine biodiversity of the region.

The MPRSWG recommendations incorporate the findings of two previous studies that dealt with the proposed location of nature reserves in the Kimberley. The first of these was the 'Conservation Reserves in Western Australia, Report of the Conservation Through Reserves Committee on System 7 to the Environmental Protection Authority 1977'. The second was the Department of CALM's 'Nature Reserves in the Kimberley' that formed the Department's submission to the Kimberley Region Planning Study (Burbridge et al. 1991). Both reports are predominantly terrestrial in their focus. For example, consideration of the Lacepede Islands and the recommendation to extend the existing nature reserves to the low water mark to ensure protection of turtle rookeries, fails to consider the conservation values of the surrounding subtidal habitat. A notable exception was the recommendation for a Class A marine park to be declared in the Roebuck Bay area (Burbridge et al. 1991).

Other conservation proposals of relevance to the marine environs of the Canning Coast region relate to the listing in 1990 of two Ramsar sites as wetlands of international importance; Roebuck Bay, and Eighty Mile Beach. The Roebuck Bay Ramsar listing primarily covers 50 000 ha of tidal mudflats of the Bay while the Eighty Mile Beach Ramsar listing covers 125 000 ha that includes the geographically separate Mandora Salt Marsh (Department of Conservation and Land Management 1990). The provision of management plans for Ramsar sites is a national obligation under the Ramsar Convention for Internationally Important Wetlands. Initiatives that contribute towards this commitment include a report to the Department of Conservation and Land Management on Management Planning for Ramsar sites in the Kimberley Region that lends further support to the MPRSWG recommendations for marine park proposals in these areas (Watkins et al. 1997). A clear understanding of the boundary of the Ramsar-listed Roebuck Bay and Eighty Mile Beach areas is considered to be a priority for management planning (Watkins et al. 1997).

The MPRSWG assessment stands apart from these conservation proposals in being the first initiative of its kind to explicitly consider the conservation values, both typical and atypical, of the state coastal waters in the region.

2.2. DIRECTING FUTURE PLANNING EFFORTS

The last three decades has seen a number of conservation proposals emerge for the Canning coast region. Whilst the nominations and listing of Ramsar sites gives clear emphasis to wetland areas, the MPRSWG report represents the first systematic attempt to consider the biodiversity values of coastal state waters with a view to identify candidate areas for marine park proposals. As the first tier of assessment, the expectation is for candidate areas to be broadly delineated, however the MPRSWG recommendations highlight the need for additional information to support even a broad level of inquiry. Their report is explicit in highlighting the need for further ecological investigations to support the more detailed stages of the planning process.

The degree of uncertainty that results from not having complete information about the system is a significant factor to consider when determining the role of the MPRSWG recommendations in directing future conservation planning efforts in the region. One risk-adverse strategy which the MPRSWG appears to have employed to counter the limited information available at the time is the broad delineation of areas. Table 2.2 highlights the high percentage of the Canning coast region's state coastal waters recommended as areas requiring some level of further assessment. Indeed, Roebuck Bay stands apart as the only area recommended as worthy of reservation that has clearly delineated boundaries for a marine park proposal. Consequently, the MPRSWG review of the Canning coast has resulted in a large extent of the coast requiring some level of further assessment, possibly as a direct result of the degree of uncertainty that prevailed due to the limited information available to support a more detailed assessment at that time.

Table 2.1. MPRSWG Recommendations for the Canning Coast, Cape Leveque – Cape Keraudren

Name	Locality	Conservation Values/Features	Tenure	Recommendation
[1A] Pender Bay - Cape Borda [1B] Sandy Point-Beagle Bay	Dampierland Peninsula	Representative of the V-shaped bays in the region, a major site of dugong hunting inferring presence of seagrass	Pastoral lease, aboriginal reserve, vacant Crown Land, Petroleum Exploration Permit EP 104R3	An area representative of the V-shaped bay systems be declared as a marine reserve
[2] Lacapede Islands	Offshore Islands, Dampierland Peninsula	Islands are nesting sites for marine turtles and seabirds. The Lacepede colonies of the Brown Booby are the largest in the world and the Lesser Frigate-bird colonies are the largest in the Indian ocean. Major rookery of the Green Turtle, nesting site for the Flatback turtle. Coral reefs noted on southern side of the West island	West Island and Middle Island are Class C Nature Reserve Sandy Island is vacant Crown Land, East Island is Commonwealth lighthouse site	Area subject to survey to determine suitability as a marine reserve.
[3] Roebuck Bay	Roebuck Bay-Lagrange Bay	RAMSAR Wetland of International Importance. Coastal bay, habitat for migratory shorebirds, wetland of international importance, mangal ecosystems, intertidal mudflats	Townsite of Broome, Aboriginal Reserve, pastoral lease, Native Title claim, Petroleum Exploration Permit EP 114R2	Candidate for reservation
[4] Cape Latouche Treville - Cape Bossut *(incl. Lagrange Bay)*	Roebuck Bay-Lagrange Bay	Low pindan cliffs and narrow beaches, complex sequence of dune-ridge barred bay systems associated with variety of habitats. Features rocky headlands with intertidal, subtidal and supratidal mud, sand and gravel flats fronting deep tidal creeks and extensive mangal ecosystems.	Not noted	An area representative of the dune-ridge bay coastal type be declared as a marine reserve Area subject to survey, with a view to select the most suitable sections for reservation
[5] Eighty Mile Beach	Eighty Mile Beach	RAMSAR Wetland of International Importance. Significant for shorebird conservation and as habitat for migratory shorebirds. Tidal flats supporting a rich community on invertebrates, mangals, supratidal samphire flats.	Beach, intertidal flats between low and high tide levels and a 40 metre strip above high tide are vacant Crown Land	An area representative of the tidal flats and extending seaward to the limit of State waters be declared as a marine reserve

Table 2.2. The areal extent of the MPRSWG recommendations as a percentage of IMCRA bioregions (state waters component).

Bioregion	state waters (ha)	% MPRSWG recommended areas
Eighty Mile Beach	414,690	100 %
Canning	168,819	69 %

A second source of uncertainty that must also be considered in reviewing the MPRSWG recommendations is the time that has elapsed since the MPRSWG first convened in 1986 and delivered their assessment in 1994. Revisiting these recommendations a decade later raises potential implications for ongoing planning processes, for what we believe we are protecting may subsequently have been degraded or in decline. Knowledge of the rates of biodiversity degradation from threatening processes or the levels of extinction risk for species of conservation significance (eg turtles and dugongs) should be taken into account when reviewing the MPRSWG recommendations. Ignoring the potential for change would be akin to a risk-seeking strategy, which assumes that the time elapsed has had no bearing on the condition of biodiversity (or its threats) and so would give the same weighting to the MPRSWG findings today as would be then.

A second issue to arise from the time elapsed since the MPRSWG put forth their recommendations relates to the recent developments in the theory and practice of marine conservation planning. The last two decades in particular, have led to considerable advancements in the theory and practice of marine reserve design and the development of more sophisticated tools (i.e.geographical information systems and reserve selection software) to support a number of approaches for the identification of marine conservation reserves. Therefore, a source of uncertainty is whether the same methodology adopted by the MPRSWG in 1986 would be considered best practice today or whether planning would be undertaken differently? Some of the approaches now available and which are being implemented globally include hotspots (Hughes et al. 2002; Roberts et al. 2002), complementarity analyses (Margules & Pressey 2000) and irreplaceability analyses (Pressey et al. 1994). The different approaches can strongly influence the perceived priorities of conservation assessments.

Australia's own policy framework for marine protected areas has also undergone considerable development with the release of a number of technical and policy documents such as the National Representative System of Marine Protected Areas (NRSMPA), the classification of ecosystem based classification for marine and coastal environments (Interim Marine and Coastal Regionalisation for Australia Technical Group 1998), the Strategic Plan of Action for the NRSMPA (Australian and New Zealand Environment and Conservation Council 1998) and Australia's Oceans Policy (Environment Australia 1998). Furthermore, in Western Australia, the statutory body responsible for management of the State's parks and reserves, the Marine Parks and Reserves Authority (MPRA), is considering the relevant benefits and costs of pursuing a bioregional approach to the establishment of marine conservation reserves as an alternative to the three-tiered system of assessment

(Marine Parks and Reserves Authority, in prep). If this approach is adopted, the Marine Parks and Reserves Selection Working Group recommended areas for the Kimberley are likely to be progressed simultaneously in a single-staged regional planning process. As conservation priorities are sensitive to decisions about the scale of the planning process (Warman et al. 2004), such uncertainty regarding the preferred approach presents a risk that conservation effort will be misdirected.

Consequently, in reviewing the MPRSWG recommendations and the direction they provide for future planning efforts, four major sources of uncertainty should be regarded:

- the limited information available to the MPRSWG at the time of their assessment;
- changes to marine biodiversity condition and threats during the time elapsed since their assessment;
- rigour of the approach adopted by the MPRSWG in view of subsequent developments in the theory and practice of marine planning and reserve design; and
- uncertainty of the exact nature and timing of future planning efforts (single park planning or regional approach).

2.3. PROJECT OBJECTIVES

The challenge for this project is to contribute to the planning of marine conservation reserves by undertaking further assessment of areas within the context of the MPRSWG recommendations, but to do so with an understanding of the uncertainty that prevailed at the time, and in view of the uncertainty of the exact nature and timing of future planning approaches.

Our preference is to adopt a risk-averse attitude and to seek circumstances in which the risk is minimised. One risk-averse response to uncertainty is to undertake further data collection and analysis. This can be best achieved by conducting a review of the information available to support further assessment for areas recommended by the MPRSWG and to enable the suitability of the recommended areas to be more clearly defined. While this approach is largely consistent with a second tier of assessment, expanding the scope of the study to the regional scale helps to offset some of the elements of uncertainty discussed previously by allowing the inclusion of additional sources of information that may not have been considered previously, or that provide a measure of the changes to biodiversity with time. Furthermore, placing greater emphasis on the capture of information and determining what key gaps in knowledge remain, rather than undertaking a conservation assessment per say, provides flexibility for future planning approaches and therefore ensuring greater utility of this studies outcomes.

Consequently, the objectives of the project are to:

- partially contribute to the biophysical and social resource assessment phase of the planning process by undertaking a review of existing ecological and social information, with an emphasis on available biophysical Geographical Information Systems (GIS) information layers; and

- manage this information for future use through the development and delivery of information products in accordance with the Department of CALM's marine information system specifications.

3. Information Requirements for Marine Conservation Planning

In Western Australia, marine conservation planning serves to identify areas for inclusion within the state wide marine parks and reserve system established under the Conservation and Land Management Act 1984 (CALM Act). The problem of determining which sites to include in the reserve system must be preceded by an assessment of the attributes of the region that the system aims to protect. This phase of the planning process is necessary for clear definition of the goals of the reserve system, in terms of just what a comprehensive, adequate and representative system will comprise.

Therefore, the basic information required to support marine conservation planning should aim to inform decision-makers about what it is that should be conserved (the biodiversity features), the spatial distribution of these features across the planning region and an understanding of how these features persist through time. However, knowledge of biodiversity alone is not sufficient, as social values play an equally important role. Indeed, both types of information are required to contribute to an understanding of the distribution, condition, threat, values and uses of the marine environment that is needed to implement management strategies for biodiversity conservation. Whilst the importance of social information in influencing conservation priorities must be clearly acknowledged, the focus of this chapter is on determining what information is needed to acquire a suitable biodiversity data set for regional marine conservation planning.

Knowing what information is available for a region serves two important roles. Firstly, it reveals the state of knowledge of the marine environment, patterns of use, existing management regimes etc. Secondly, it supports a gap analysis of the extent to which information needs are met. Such an assessment is crucial to enable the development of conservation strategies that effectively manage for the limitations in knowledge. The better the information with which to make the decision, the greater the precision that can be applied to direct the planning outcomes. Conversely, limited or inappropriate data are likely to result in poor choices of priority areas (Ward et al. 1998).

This chapter commences with a brief review of the current principles and guidelines on the information requirements of marine conservation planning. Surprisingly, the documentation of current practices is rather limited despite the global application of marine planning processes. It is encouraging to note that the Department of CALM's Marine Conservation Branch (MCB) has developed a general framework to assist in the preparation of information to support marine conservation planning processes (Hill & Ryan 2002). As this document is publicly available, only a brief summary of their approach is provided here.

3.1. THE THEORY SUPPORTING INFORMATION NEEDS FOR CONSERVATION PLANNING

In most planning exercises, there is a vast gap between the level of information required and that which is available. A number of strategies have been devised to manage for such uncertainty but common to all is the fundamental requirement to employ the use of surrogates. The choice of surrogates is important as it affects how well we achieve the goal of comprehensiveness and depends on the extent that the chosen surrogate provides concordance for biodiversity that is unknown and unmeasured. In general, three types of surrogates are defined: taxon-based schemes, species assemblages and environmental domains (Margules et al. 2002).

Taxon-based schemes refer to the use of species or higher taxa (eg genera) as surrogates for regional biota whose spatial distributions are poorly known (Andelman & Fagan 2000). Such taxon-based surrogate schemes can apply different approaches to define the surrogate species. For example, umbrella species are regarded as species that require such large areas of habitat that their protection guarantees that the requirements of sympatric species are also met (Caro & O'Doherty 1999). Indicator species have also featured prominently, based upon their suitability for survey. In general however, it is often the case of not knowing in advance which species are likely to be important. Consequently, the choice of taxa has largely been ad hoc and generally limited to taxa that we have good information about, rather than those that adequately represent biodiversity as a whole. There is the added concern that when species are examined individually, their spatial population dynamics are usually ignored (Cabeza & Moilanen 2001).

Assemblages describe a range of classifications applied to describe generalised biodiversity entities more heterogeneous than taxa, such as communities, associations and habitat types. Assemblages are distinct from taxa in that they represent various combinations of species and the interactions between them and so capture a greater level of ecological complexity than is achieved using just individual taxa. They can be derived by using dominant species or from field data with numerical pattern analysis (Margules et al. 2002).

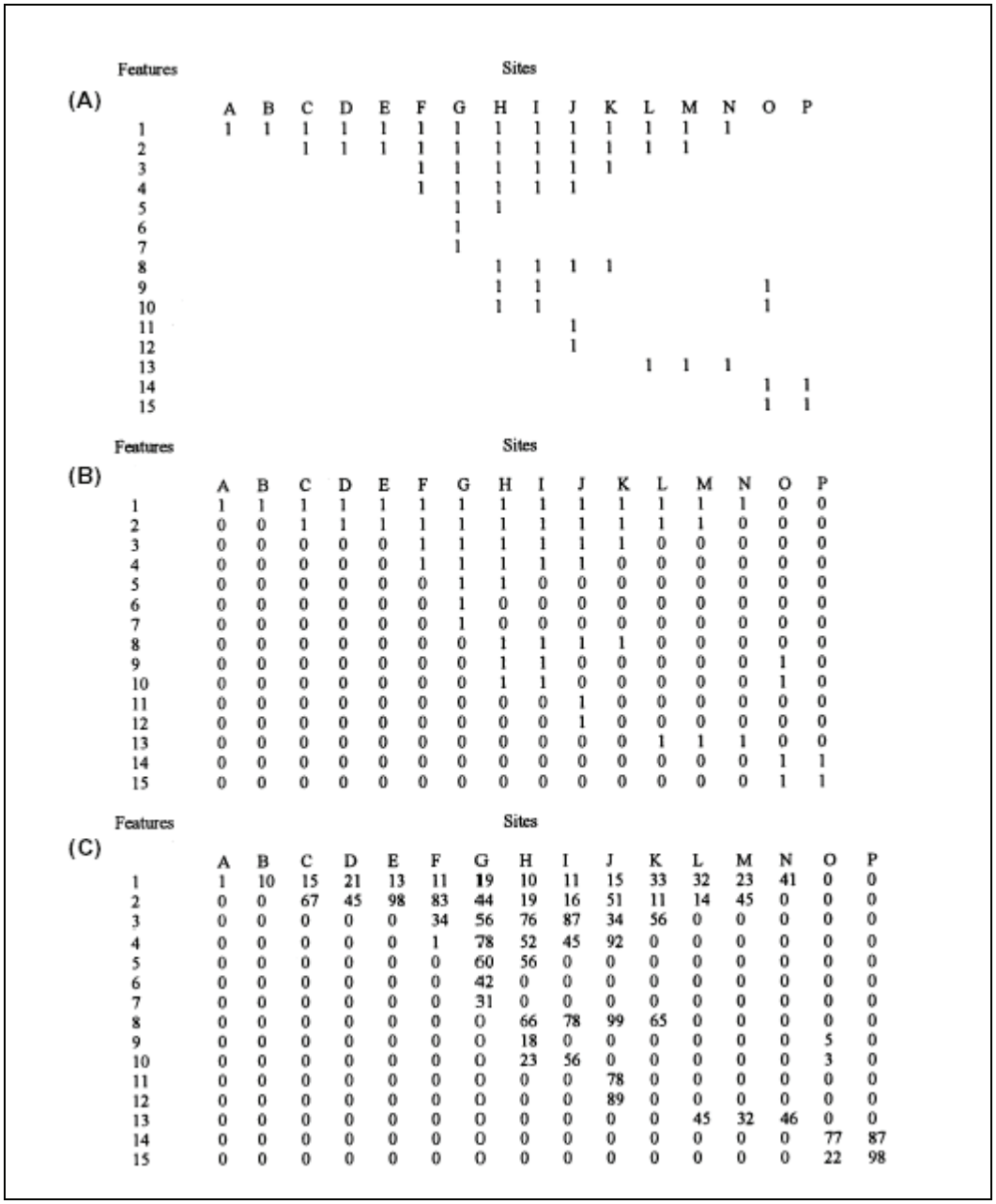
Environmental surrogates generally extends to classifications based on physical variables though may include biotic variables such as vegetation. The variables themselves may also be directly used as surrogates (eg salinity, turbidity, rugosity) as it is assumed that species distributional patterns are linked to variation in the environment and reflect the extent to which a given set of conditions represents a niche (Margules et al. 2002). Sampling across the range of a variable (eg substrate types), is likely to capture a range of different species, although in practice the links between environmental variables and the distribution and abundance of non-target species are poorly known. Use of these more general environmental classes poses a risk that the heterogeneity within a class will be ignored. However, environmental data has the advantage of being relatively cheap to acquire and more widely available than biological data.

A detailed discussion of the different strengths and weaknesses of each of these types of surrogates is provided by Margules et al (2002) and Ward (1998). Importantly, the strengths of the different surrogate types are largely complementary. For example,

taxa survey data contributes direct information of the distribution of selected entities of biodiversity but often with limited coverage, while environmental data often provides complete spatial coverage but the level of congruence with actual species distributions may be poor (Ferrier 2002). Common practice therefore, is to apply a combination of all types of surrogates. Using biological and environmental surrogates together is akin to a coarse filter/fine-filter strategy to biodiversity conservation (Noss 1990).

Of course not all biodiversity surrogates are equal because not all are subjected to the same degree of threat. A sufficiently detailed data set on the biodiversity of the planning region needs to support a further level of analysis to assign a conservation value to individual surrogates according to defined criteria such as uniqueness, rarity and vulnerability that is then used to determine the appropriate level of representation required for their persistence. This stage of the planning process requires a data set that captures information beyond what is merely contained in the planning region, but reports on the spatial pattern of biodiversity. Notably, this pattern is largely relative to the delineation of the selectable areas or planning units. So deciding how much of each biodiversity feature to represent in the reserve system is ultimately determined by the properties of the individual sites. The basic data set must therefore report on the distribution of the chosen biodiversity surrogates (ie features) across the candidate sites. This type of information is typically represented in a sites by features matrix as presence data, presence/absence data, abundance data or probabilistic data, described as follows:

- Presence data - The most common type of information that is recorded is the presence only data that is derived from records of the geographic locations of taxa. While such information obviously denotes where a taxon occurs, it is not known whether a non-occurrence is a true absence or simply a result of the taxon not having been looked for there. Consequently, a species may incorrectly appear to be absent from a particular location simply because the location was never surveyed. This problem of false-absences is likely to increase with the shift from broad-scale to fine-scale planning.
- Presence/absence data - Data compiled as presence/absence records is often gathered by systematic biodiversity surveys. Here, the absences are real meaning that the features were looked for and recorded as present where they were found and absent where they were not found.
- Abundance - Biodiversity data can be reported as a measure of a feature's abundance. This may represent the number of individuals present in a site or, for assemblage or environmental data, would comprise a record of the areal extent of a biodiversity surrogates in a site. Abundance data has the advantage of providing additional information about the properties of a site by including information about the quantity of a feature and not just presence.
- Probabilistic data - If the available biodiversity data represents a combination of biological and environment features then modelling distributions of individual species in relation to environmental variables can be used to generate probabilistic data that records the likelihood that a feature is present given some combination of mapped variables.



(A)

Features	Sites															
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
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2			1	1	1	1	1	1	1	1	1	1	1			
3						1	1	1	1	1	1					
4						1	1	1	1	1						
5							1	1								
6							1									
7							1									
8								1	1	1	1					
9								1	1						1	
10								1	1						1	
11										1						
12										1						
13												1	1	1		
14															1	1
15															1	1

(B)

Features	Sites															
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
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(C)

Features	Sites															
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	1	10	15	21	13	11	19	10	11	15	33	32	23	41	0	0
2	0	0	67	45	98	83	44	19	16	51	11	14	45	0	0	0
3	0	0	0	0	0	34	56	76	87	34	56	0	0	0	0	0
4	0	0	0	0	0	1	78	52	45	92	0	0	0	0	0	0
5	0	0	0	0	0	0	60	56	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	42	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	31	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	66	78	99	65	0	0	0	0	0
9	0	0	0	0	0	0	0	18	0	0	0	0	0	0	5	0
10	0	0	0	0	0	0	0	23	56	0	0	0	0	0	3	0
11	0	0	0	0	0	0	0	0	0	78	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	89	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	45	32	46	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	77	87
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	98

Figure 3.1. Three kinds of sites X features matrices showing (A) presence only data, (B) presence/absence data, and (C) abundance data. ***derived from Margules et al 2002***

Ideally, biodiversity data is available uniformly across the planning region and at a resolution that is commensurate to the scale at which decisions are made. If these requirements are not met, then the selection process risks strong bias towards areas on the basis of sampling effort rather than due to their biodiversity properties (Noss 2004).

3.2. A FRAMEWORK TO GUIDE THE CAPTURE OF INFORMATION FOR MARINE RESERVE PLANNING IN WA

In Western Australia, a framework to assist in the preparation of information for the planning of marine reserves has been prepared by the Department of CALM (Hill & Ryan 2002). It serves as a guide for the information-gathering phase of the planning process that is generically known as the Resource Assessment. It states support for spatial and non-spatial information from a range of custodians such as government and non-government organisations. The framework places considerable emphasis in specifying the information to be targeted and the level of detail at which it is be targeted, for compilation into an accurate information document, generally referred to as the Resource Assessment document.

Under this framework information is classified as either ecological or social.
Ecological values are identified through a series of key questions that are addressed under the following fields:

- Geology and Geomorphology
- Drainage and Groundwater
- Climate
  Oceanography
- Bathymetry
- Ecological Communities
- Marine Fauna
- Marine Flora, Protists and Bacteria
- Coastal Terrestrial Biota

Social values are similarly identified through a series of key questions addressed under the following fields:

- Cultural History
- Tenure
- Infrastructure and Facilities
- Water Quality
- Commercial Fishing
- Aquaculture and Pearling
- Tourism
- Mining and Petroleum
- Recreational Fishing
- Non-Extractive Recreational Activities
- Education

In addition, the framework prescribes that this information be captured in an accurate information document that possesses the following properties:

- Up to date;
- Include spatial representation of data;
- Clear identification of sources (i.e. well referenced);
- Clear identification of priorities for future information collection;
- Primarily for internal use; and
- Facilitate easy retrieval of information.

The question-style format serves as a prompt to capture knowledge of the planning region that is mostly derived through non-spatial data. A degree of overlap exists between the information targeted through the framework and that which has been recently captured through the efforts of the Rangelands Co-ordinating Group and the Interim Kimberley Natural Resource Management Group. The information provided in the draft Kimberley Natural Resource Management Plan (Holmes 2004) and the draft Rangelands Natural Resource Management Strategy (Rangelands NRM Coordinating Group 2005) should be consulted in future marine planning processes, for they represent useful resource documents.

To support the capture of spatial information, the resource assessment framework links to the Department's Marine Information Section's data acquisition program. This program is concerned with the ongoing development of a marine information system for marine reservation and management and identifies spatial datasets required to support this purpose.

Spatial data is organised somewhat differently to the ecological and social groupings mentioned above. It utilises eleven classifications as follows:

- Coastline
- Contextual
- Ecosystem
- Fauna
- Flora
- Geoscience
- Hydrology
- Hypsography
- Meteorology
- Oceanography
- Social

A more detailed description of the attributes of each of these classifications is provided in Appendix 1 of Hill and Ryan (2002). Notably, the type of information that is targeted combines a coarse-scale/fine-filter approach. One limitation however is the lack of guidance for determining what quality of data is accepted, in terms of the resolution, consistency or uniformity of information across the planning region.

4. A spatial framework for marine conservation planning

A generic framework for the management of spatial data is under development by the Marine Information Section (MIS) of the Department of CALM's Marine Conservation Branch. Over the last decade, this framework has been successfully applied to the planning of a number of marine conservation reserves in Western Australia. This chapter outlines the approach taken to apply this framework to perform an audit of spatial information for the Canning coast. It involves four key activities described as follows:

- Spatial data directories/databases search;
- Data documentation;
- Acquisition of data (implement license agreements, custodian requests, downloads); and
- Management of data within a spatial information system for the Canning coast.

4.1. SPATIAL DATA DIRECTORIES/DATABASES SEARCH

The focus of the audit was to identify and capture existing marine environmental spatial information for the Western Australian state waters of the Canning coast, with a particular focus on the areas recommended by the MPRSWG (Marine Parks and Reserves Selection Working Group 1994). Database searches targeted key areas of interest that were defined by the following rules:

- Spatial limits: The region of interest was defined as the Western Australian state coastal waters corresponding to the Canning and Eighty Mile Beach IMCRA bioregions of the Canning coast. Approximate geographic coordinates for this area were defined (16°- 20°S, 119°-123°E). Datasets that extended beyond this boundary were still included and their geographic extent noted. In general, application of this rule was inclusive of coastal and estuarine areas.
- Temporal limits: Undefined - all historical and available data for the region were of interest.
- Topic/keyword limits: In general, the topic and keywords reflected a focus on marine environmental data. Specific terms were often determined according to the format of the database search engine. Some databases/directories had defined themes and topics, in which case a selection of relevant themes were used, while other databases allowed for keywords to be entered.

In addition, a general search of state and federal government department and Western Australian university websites was conducted to locate any relevant data that, whilst not registered in a data directory, may still be of interest. A register of the databases and directories consulted and the search limits applied has been compiled (Table 4.1). This level of documentation is intended to facilitate the future review and assessment of spatial information that is likely to follow the completion of this project and which will be required to support the ongoing marine conservation planning processes.

Table 4.1. Register of spatial database and directories consulted and search limits applied to perform the spatial information audit

NAME	Aboriginal Heritage Sites Register
Access	http://www.dia.wa.gov.au/Heritage/heritage_Sites_Register.aspx
Overview	The ABORIGINAL SITE REGISTER contains information on over 20,100 Aboriginal sites throughout Western Australia. The Register is held under Section 38 of the State's Aboriginal Heritage Act 1972 and hosted by the Department of Indigenous Affairs. The electronic portion of the Register contains a brief description of the site, the site type, the site informants (usually the Traditional Owners) and a map showing the site boundaries and location. Where the informants have requested the site information be kept confidential, the location of the site is censored by placing one or more 2km square boxes over the extent of the site.
Search Limits	geographical limits 16°- 20°S, 119°-123°E)
Results	Updated dataset of registered sites provided.
NAME	Australian Natural Resources Atlas
Access	http://audit.deh.gov.au/ANRA/atlas_home.cfm
Overview	The ANRA Data Library was developed in partnership with the National Land and Water Resources Audit to provide a system for discovery and access to data and information about that data, using the latest International (Metadata) Standards for describing data so that it is compatible with both Australian and International systems. It includes data stored and managed by the Bureau of Rural Sciences on behalf of a number of organisations and serves to assist in the distribution of data provided by the National Land and Water Resource Audit.
Search Limits	Searchable Terms “marine”, “climate and weather”, “ecology”, “fauna”, “fisheries”, “flora”, “oceanography”
Results	provides a regional profiling tool that summarises the condition of land and water resources. Includes the results of the Estuary Assessment 2000 which assessed the condition of 979 estuaries and classified each estuary by the key geomorphological processes driving it.
NAME	Australian Spatial Data Directory
Access	http://asdd.ga.gov.au/asdd//
Overview	The Australian Spatial Data Directory (ASDD) provides search interfaces to discover geospatial dataset descriptions (metadata) throughout Australia. A dataset description is a concise document which consistently explains a certain set of geospatial (earth-related) data, and provides links to further information and possibly to the actual data. The ASDD is an ANZLIC - the Spatial Information Council Australian Spatial Data Infrastructure (ASDI) initiative. The gateways to the ASDD is maintained by Geoscience Australia on behalf of ANZLIC .
Search Limits	“marine”, “fisheries” AND “Northern Western Australia”, “Kimberley”
Results	identified a large number of spatial datasets

Table 4.1. Register of spatial database and directories consulted and search limits applied to perform the spatial information audit *(continued)*

NAME	Australian Wetlands Database
Access	http://www.deh.gov.au/water/wetlands/database/index.html
Overview	Hosted by ERIN, the Australian Wetlands Database provides information on Australia's Ramsar sites and nationally important wetlands listed in A directory of important wetlands. Information and spatial data for Australia's Ramsar sites are supplied by State and Territory conservation departments. The reports generated from the database follow the categories of the Ramsar Information Sheet (RIS), which document the character and values of each Ramsar site. The latest RIS updates are included.
Search Limits	"Roebuck Bay", "Eighty Mile Beach" and search by geographical limits N-16°- 20°S, 119°-123°E
Results	Provides information sheets for listed wetlands compiled by the Department of Conservation and Land Management (DCLM). Describes the ecological features and noteworthy fauna of the Roebuck Bay and Eighty Mile Beach Wetlands.
NAME	Environment Data Directory
Access	http://www.deh.gov.au/erin/edd/
Overview	Hosted by ERIN, the Environmental Data Directory holds information on datasets held by the Department of the Environment and Heritage. Data is available for downloading where this is possible.
Search Limits	"marine", "Northern Australia", search of datasets available for downloading
Results	identified a number of datasets held by the Department of the Environment and Heritage
NAME	MARLIN
Access	http://www.marine.csiro.au/marlin/
Overview	MarLIN is being developed as the searchable metadatabase (directory of datasets) for data held by the CSIRO Division of Marine Research (CMR). It is an initiative of the Divisional **Data Centre**. MarLIN is designed to hold descriptions of datasets collected by, or currently held within, the CSIRO Marine Research plus its predecessors (Divisions of Fisheries, Oceanography, and Fisheries & Oceanography). MarLIN also provides details of, or on-line links to, supporting information such as documentation, images, WWW sites with further information, and the data itself where this is available for delivery over the world wide web.
Search Limits	Geographical limits 16°- 20°S, 119°-123°E
Results	identified metadata for research voyages, fish distributions and oceanographic data
NAME	Marine Information System, Marine Conservation Branch, Dept CALM
Access	Departmental Access Only Senior Information Officer CALM, Marine Conservation Branch 47 Henry St, Fremantle, 6160 PH: 61 08 93360109 Fax:61 08 94305408 Email: rayl@calm.wa.gov.au

Table 4.1. Register of spatial database and directories consulted and search limits applied to perform the spatial information audit *(continued)*

Overview	MIS is the internal spatial database for the Marine Conservation Branch (MCB) Department of Conservation and Land Management (CALM). Both custodial and required non custodial spatial data is maintained under standards and protocols designed to meet CALM's marine conservation management requirements. Data and metadata are linked and stored within a logical directory structure on an internal server available to MCB staff.
Search Limits	Physical search of data directory
Results	Identified a number of datasets for which the department is custodian in addition to datasets that while MIS is non-custodian it receives regular updates.

NAME	Neptune
Access	http://neptune.oceans.gov.au/
Overview	Neptune is the online data directory for the National Oceans Office. It allows users to search for marine related data against a directory of datasets (metadatabase). It also provides details of, and on-line links to, supporting information such as documentation, images, internet sites, and the data itself where this is available for delivery over the World Wide Web.
Search Limits	Geographical limits 16°- 20°S, 119°-123°E
Results	provides a number of maps displaying ecological and non-fisheries uses for Australia's marine jurisdiction that are registered on the metadata database

NAME	Species of National Environmental Significance Database
Access	http://www.deh.gov.au/erin/edd/ (access through search of environment data directory)
Overview	The Database of Species of National Environmental Significance stores maps and point distribution information about Species of National Environmental Significance as listed in the Environment Protection and Biodiversity Conservation (EPBC) Act 1999, and, also weeds and feral species. Species covered include marine species.
Search Limits	Searchable Terms "marine"

NAME	Visible earth database
Access	http://www.visibleearth.nasa.gov/
Overview	A catalogue of NASA images and animations taken using satellite and remote sensing. Categories include agriculture, oceans, human dimensions.
Search Limits	Searchable Terms "Northern Australia"
Results	identified images of fire occurrences in northern WA , coastal phytoplankton blooms along the northern coast of Western Australia. http://visibleearth.nasa.gov/view_rec.php?id=1233, tropical cyclones and a range of assorted images.

Table 4.1. Register of spatial database and directories consulted and search limits applied to perform the spatial information audit *(continued)*

NAME	WALIS Interrogator
Access	http://www.walis.wa.gov.au/interragator/
Overview	Interrogator is the first step in accessing geographic and land information in Western Australia. With it you can search a comprehensive index to over 10,000 records of Western Australia's geographic and land information held by public and private sector organisations. Interragator Online is part of the Australian Spatial Data Directory (ASDD) which links various directory services around Australia.
Search Limits	"climate and weather", "ecology", "flora", "fisheries", "fauna", "marine", "oceanography", "vegetation", "water" AND geographical limits providing coverage of the Canning and Eighty Mile Beach bioregions
Results	identified a large number of spatial datasets that are reported in the metadata database
NAME	Western Australian Maritime Museum Online Databases
Access	http://dbase.mm.wa.gov.au/shipwrecks/shipwreck.php
Overview	Department of Maritime Archaeology Western Australian Maritime Museum Shipwreck Database Search Facility gives out information on Western Australian shipwrecks.
Search Limits	Provides droplists to define search terms. Default settings used in combination with "North West (Eighty Mile Area)", "North West (Lacepedes Area)", or "North West (Broome area)".
Results	Provides information on registered shipwrecks in the locality. Detailed archaeological descriptions provided. Thirty three records shown for Eighty Mile Beach, 173 shipwrecks reported for the Broome Area and a further 58 for the Lacepedes area.
NAME	World Atlas of Seagrasses
Access	http://www.unep-wcmc.org/marine/seagrassatlas/
Overview	The Atlas is a collaboration of more than 50 authors from 25 nations. Fully illustrated, the Atlas contains the first global and regional maps of seagrass distribution and a wealth of information on key issues concerning this ecosystem. The Atlas summarises the opinion and science of the world's leading experts on the global status of the ecosystem.
Search Limits	Searchable Terms "Western Australia"
Results	Supporting information is provided by Di Walker. The interactive map service presents species distribution maps for seagrass species. Coverage is broad.

4.2. DATA DOCUMENTATION

The spatial database and data directory search resulted in the identification of more than 100 metadata entries that describe spatial datasets with the potential to contribute to the information requirements of marine planning in the Canning coast. Metadata simply defined means "data describing data". It includes, but is not restricted to, characteristics such as the content, quality, currency, access and availability of the data. For spatial information or information with a geographic component, metadata

deals with the "what, when, who, where and how" of the data (ANZLIC Metadata Working Group 2001). These characteristics should typically conform to ANZLIC standards outlined in the ANZLIC's Metadata Guidelines developed in 1996 and which have since been widely accepted in Australia's spatial information community.

Capturing the metadata records for spatial datasets demonstrated a need to document and manage the information in a manner which facilitates future queries of the type and usefulness of the data found. This prompted the construction of a Microsoft Access© database to:

- provide an inventory of the results of the database search;
- capture characteristics of the metadata to assist with data assessment (to determine fitness for use); and
- include additional fields to provide a link to the Department of CALM's MIS specifications for data retrieval and access.

The metadata elements required for the audit and which were included in the database are reported in Table 4.2. These fields are consistent with the ANZLIC standards and provide information at a level of detail that is consistent with "data discovery" purposes. The inclusion of additional customised fields ('MIS Category ID' and 'MIS Category Class') ensures a link between the database record and the Dept. of CALM's MIS framework for the management of spatial data.

4.3. ACQUISITION OF DATA

Data acquisition proceeded according to the access constraints of the respective datasets. Generally, four levels of restriction are likely to apply:

- accessible – no constraints;
- accessible by arrangement with relevant custodian(s);
- accessible subject to Data Use Agreement; and
- accessible subject to formal license agreement.

All levels of access restriction were encountered and access was sought accordingly. In the majority of datasets, access required authorisation through arrangement with the relevant custodian and this often led to lengthy delays in responses or in some cases, no response from the custodian at all. Obviously, an inability to access the data prevented any further assessment of the data's utility for marine conservation planning.

Table 4.2. Metadata elements required for the audit of spatial information

Header: Metadata	
MetadataID:	Autonumber
MetadataName:	Name of Dataset
MIS Category ID	a classification of the data type using the Dept of CALM's MIS 'category' groupings
MIS Category Class	a classification of the type of data type using the Dept of CALM's MIS 'class' fields
DatasetDescription:	A brief narrative summary of the content of the dataset
Custodian	The organisation responsible for the data
KeyWords:	Words likely to be used by a non-expert to look for the
Geographic Extent:	A list of predefined geographic objects that show the extent of coverage of the dataset.
Currency-BeginDate:	Earliest data of records in the data
Currency-EndDate:	Last date of information in the data
Notes	
Access-DataFormat:	The format in which the dataset is stored
Access-Available Format Type:	The format in which the dataset is available
Access-Constraint:	Any restrictions or legal prerequisites that may apply to the access and use of the dataset including licensing, liability and copyright
Data Quality:	(Lineage) A brief summary of the A brief history of the source and processing steps used to produce the dataset
Positional Accuracy:	A brief assessment of the closeness of the location of spatial objects in the dataset in relation to their true position
Attribute Accuracy:	A brief assessment of the reliability assigned to features in the dataset in relation to their real world values
Completeness:	A brief assessment of the extent and range in regard to completeness of coverage, completeness of classification and completeness of verification
Additional Metadata:	References to other directories or systems containing further information about the data. Also provides reference of ANZLIC Unique Identifier
Suitability for Conservation Planning:	An assessment of the utility of the dataset for marine conservation planning, undertaken as part of the Canning Coast Biophysical Resource Assessment. For internal use only.
Navigation: Metadata	

4.4. MANAGEMENT OF DATA WITHIN A SPATIAL INFORMATION SYSTEM FOR THE CANNING COAST

The previous tasks of identifying metadata, data documentation and acquisition of spatial datasets provide the necessary elements to support the development of a spatial information system for the Canning coast. Here, we are concerned with the delivery of available information in a format that will contribute to ongoing marine planning processes and natural resource management generally. Consequently, this task focused on the organisation of metadata and the corresponding datasets (where

licence agreements permitted) according to the classification system developed by the Department's Marine Information Section's framework for management of spatial information. This information is provided on the CD accompanying this report in a format that displays geographically referenced information, subject to data restrictions, together with the associated metadata. It is intended to enable broad access to spatial data for a range of users, or at least ensure that individuals can acquire some knowledge of what information exists with details of the data custodians and direction on how the datasets can be accessed.

An assessment of the fitness of the spatial data for use in conservation planning, whilst initially intended, was not permitted due to time constraints. However, it is clear that a large number of the spatial datasets will require some level of additional processing to make them fit for use for marine planning.

5. Research and Monitoring Database

The development of a research and monitoring database has proved to be a useful resource for marine conservation planning in Western Australia. It offers an up to date inventory of past and current research and monitoring projects whilst also providing a link to published findings of these studies. As it provides a record for projects not yet completed and projects of an ongoing nature, it is a useful prompt for planners to acquire updated or newly released information. Finally, it can support an assessment of the rate that new information is being acquired. Such an assessment can provide valuable insight into the completeness of past assessments and provide a trigger to re-examine priorities as knowledge accumulates.

This chapter describes the approach taken to identify research and monitoring projects that have been or are being undertaken in the Canning Coast region. It involves three tasks, described as follows:

- existing research databases search;
- identification of additional projects; and
- compilation of project details in the Canning Coast research and monitoring database.

The database itself forms an appendage to this report.

5.1. EXISTING RESEARCH DATABASE SEARCH

An initial list of current marine research and monitoring projects was sourced from the MCB's 2004-2005 current research database. This database focuses mainly on research relevant to marine reserves in WA, both existing and proposed. While much of the information sourced from the database was outside the planning region, a project was included if found to be of interest to the ecological or social values of the Canning region, for example, dugongs, turtle, mangroves and cetaceans.

All projects registered in the MCB 2004-2005 research database had been granted a Department of CALM licence to conduct their research. This meant that before a project was listed in the Canning Coast database, updated project details, contact details, and research reports were sourced from license applications.

5.2. IDENTIFICATION OF ADDITIONAL PROJECTS

The search for additional research and monitoring projects targeted past and present projects in the Canning Coast region, as well as potentially related research occurring outside the planning region but including the Pilbara and Kimberley areas and research being conducted on a state wide level. The key sources used to identify new research and monitoring projects include:

- CALM Licenses
  Details of new license applications granted to researchers in the Canning Coast region were identified.
- Universities
  A selection of staff, PhD candidates and undergraduate (honour) students were contacted at Western Australian universities including Curtin University, Edith Cowen University, Murdoch University and University of Western Australia. Interstate universities such as James Cook University and overseas universities such as Simon Fraser and University of Groningen were also contacted where prior knowledge of research activities existed.
- Government Agencies
  Staff from various Government organisations including Department of CALM, Department of Fisheries, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australian Institute of Marine Science (AIMS), Department of Environment and Heritage, Department of Planning and Infrastructure, Department of Indigenous Affairs and various councils in the Kimberley region were contacted.
- Non-government organisations
  Staff from various organisation including World Wildlife Fund (WWF), Kimberley Land Council, Rubibi Land Heritage and Development Group, Roebuck Bay Working Group, Broome Birds Observatory and Birds Australia were contacted.
- Internet search
  Internet searches using keywords were also conducted to obtain information on projects. Internet searches targeting specific researchers proved to be a useful means of acquiring information on projects where attempts to contact the researchers were unsuccessful.

5.3. COMPILATION OF PROJECT DETAILS

The Canning Coast research and monitoring database was created using Endnote 8© software. A new reference type 'research and monitoring' was generated to capture the relevant information. All information collected was entered under the field headings described in Table 5.1. In addition, details of each individual contacted throughout the reference search were entered into a contact database (see Chapter Seven).

It is intended for the database to be maintained and regularly updated by the MCB as a key resource for future planning processes. However, in view of the license restrictions of Endnote 8© software and for the purpose of reporting on the outcomes of this project, the contents of the database have been exported and formatted for web browsing on the CD.

Table 5.1. Information compiled in the customised Research and Monitoring Reference Type (Endnote 8 ©)

Customised Research and Monitoring Database Fields	Field Description
Investigators:	Principal and co-researchers of the project
Title:	The name of the project
Research/monitoring:	Whether the project was research or monitoring
Date Commenced:	When the project started
Date Completed:	When the project finished
Type of work:	A description of the type of project (eg PhD, Honours, Survey, Management Plan)
Status:	Whether the project is in progress/complete or ongoing
Associated institutions:	Organisations that contributed to the project
Supervisors:	People that supervised the PhD and Honour students
Funding source/amount:	the organisations that funded the project / the amount of money/inkind received from the organisation
Study area:	The extent of coverage of the research/monitoring project
Category ID:	A classification of the research/monitoring type using the Dept of CALM's MIS 'category' grouping
Category Class:	A classification of the research/monitoring type using the Dept of CALM's MIS 'class' field
Keywords:	Words likely to be used by a non-expert to look for the project
Project brief:	A brief summary of the aims/objectives and outcomes of the project
Research notes:	general notes regarding the project
Website:	link to website
Link to PDF/publications:	links to the project proposal/brief/reports within the Canning Coast database and lists of past publication
Contact details:	includes email, phone number and address of the principal investigators

6. Reference Database

This chapter describes the approach taken in the development of the Reference Database for the Canning Coast. The Reference Database is an important resource for marine conservation planning processes as it provides an up to date record of published marine environmental and social literature for the Canning coast planning region. Current knowledge of the region is mostly derived from these published sources (i.e. reports and surveys).

6.1. LITERATURE SEARCH

A review of existing literature was conducted by searching a number of databases, library catalogues and websites. These resources were searched in different ways depending upon the format of the resource. Search limits are described in Table 6.1. Temporal limits were not set as all references relevant to the region were of interest. Topic/keyword limits were determined according to the format of the resource search. Some resources had specific topics, in which case those topics were used, while other resources allowed for keywords to be entered (e.g. libraries & MCB database etc). The state and federal government department websites were searched manually and various internet search engines were used to find any relevant references. If complete documents could not be downloaded from websites or a particular reference could not be found they were then sourced through CALM's Science library (CONSlib).

Table 6.1. Resources consulted and search limits applied for compilation of the Reference Database

Resource	Topics/keywords	Spatial limits
Libraries (LISWA, universities)	80 Mile Beach, Broome, Kimberley, marine, biology, habitats	None
Journal databases (Wiley Interscience and ISI Web of Science)	Geology/geomorphology Drainage/groundwater Currents/oceanography/tides/waves Marine flora/fauna Coastal/marine habitat Dugong/whale/turtle/mammals/fish Seagrass/mangroves	All searches were limited by including Western Australia AND north as a keyword
State and federal government department websites	Kimberley, Broome, Eighty Mile Beach, Lacapede, Roebuck Bay, marine, biology, habitats, RAMSAR	none
Conservation Library database (CONSlib) http://www.naturebase.net/science/science.html	Kimberley, Broome, RAMSAR, Eighty Mile Beach, Islands, Lacapede, Dampierland Peninsula Marine flora/fauna Coastal/marine habitat Dugong/whale/turtle/mammals/fish Seagrass/mangroves	none
Dept CALM's Marine Conservation Branch Library	Kimberley, Broome Eighty Mile Beach, Broome, Lacepede, Roebuck Bay	none
Internet Search Engines (Google)	Any keyword relevant to the topic being search	none

6.2. DOCUMENTATION AND MANAGEMENT OF REFERENCES

More than 200 references were identified through the search and their details registered using the Endnote 8 © software. A database was created and standard settings applied. Where time permitted, hardcopies of references were obtained, with copies placed in the MCB's library. To enable broader access to interested parties the results of the database have been exported and saved in pdf format. The information comprises an appendix to this report. An output of the database has been saved to the CD, together with references that were available in an electronic format.

7. Contacts Database

Marine conservation planning requires substantial community involvement, particularly during the third tier (formal stage) of the planning process. A contacts database is therefore a key resource that enables interested individuals, stakeholders, relevant government agencies and non-community organisations to register their interest in the planning of marine conservation reserves and receive updates on recent progress. This project has established a contacts database for the Canning Coast. Details were obtained for individuals who were contacted as part of the audit of spatial datasets, in the development of the Research and Monitoring Database, in the development of the Reference Database or with whom we had interaction during field trips.

Due to some individuals wishing to maintain confidentiality, this database will remain restricted access, with contact details only provided upon request and following the prior approval of the relevant individual. The database will be maintained by the MCB.

8. Key Findings and Summary

The task of compiling information on the biodiversity of a region will never be complete. Instead, it becomes a question of how much effort to invest in the acquisition of information, in view of the urgency with which management decisions are required. The challenge is to know when the information at hand is adequate to fulfil the planning objectives. This is complicated by the fact that biodiversity data are often collected to support objectives other than conservation planning (eg. environmental impact assessments, port surveys), hence not only must we address the issue of whether the data exists, but whether it exists in a format that is suitable to inform decision making about which and how many sites are needed for a comprehensive, adequate and representative marine reserve system. A brief discussion of some of the issues relating to the desirable properties of data was provided in Chapter Two.

To summarise the spatial information captured in this project, a matrix has been prepared to compare the datasets identified from the audit of spatial information with the required datasets for marine reservation and management. This information is presented in Table 8.1 and indicates whether spatial information for a particular category or class of data exists (status), then reports on the extent to which that dataset provides coverage for the planning region (geographic coverage). It must be noted that these assessments are based on the metadata for the spatial datasets and not from

a review of the spatial dataset itself. Indeed, an important next step in the planning process is to acquire, review and fully determine the value of all spatial datasets for marine planning in the Canning coast region.

The status of the dataset is clearly of interest, for if data on a feature are incomplete or non-existent, then it is not likely to influence the selection process. Geographic coverage is included as it is typically reported in the metadata and is a key property of the dataset for planning. Biases in data coverage can misdirect conservation efforts if not properly addressed (Ardron et al. 2001). For example, patchy or incomplete data can exaggerate the conservation value of a particular site due to sampling effort being non-uniform across the planning region of interest. Recognising how the different properties of the data are likely to influence the planning outcomes is key, for the existence of a dataset does not guarantee its utility for conservation planning. Data gaps that have been identified in Table 8.1 for biophysical data are explained below. As the capture of social datasets was largely opportunistic, an assessment of gaps is not meaningful at this stage.

Coastline - Seemingly adequate from review of the metadata, however the Department's Marine Information Section has alerted us to the positional inaccuracies of the underlying spatial dataset. In particular, the extreme tidal range experienced along the coast presents some ambiguity in the mapping of the low and high water mark. This can be problematic when attempting to aggregate other spatial datasets to matching shorelines.

Contextual - Limited contextual data is available and is spatially patchy. Investment of further effort to acquire additional contextual data should be weighed against the considerable data processing and classification that may be required. There is considerable potential for remote environmental mapping, derived, for example, from interpretation of satellite imagery or from numerical classification of abiotic environmental layers. Although this alternative approach confers obvious benefits in terms of cost-effectiveness and rapidity of application, problems may arise if congruence is poor between mapped environmental-classes and actual biological distributions (Ferrier 2002).

Ecosystem - Habitat presents some obvious gaps in spatial information and yet it encompasses the key ecological values to be included within a marine conservation reserve. The best-described habitats are coastal and include mangroves, estuaries, wetlands and intertidal habitats. Even for these habitats, the available spatial information is patchy and provides incomplete coverage across the region. Estuaries and wetlands risk being given greater emphasis due to greater sampling effort alone. Spatial information of coral reef, macroalgal and deep water systems along the Canning coast appear to be almost non-existent, with data of seagrass assemblages also limited. We are aware that some additional information is available in published and unpublished reports and should be compiled to assist with the design of systematic and comprehensive surveys.

Fauna - Spatial datasets for faunal species largely reflect site specific survey efforts, rather than targeting species that have merit as surrogates for biodiversity. It is recognised that much of the data is dated (WA Museum Database records date from 1895) and may be of limited use, with coverage patchy across the Canning coast

region. Faunal experts with whom we have had discussions acknowledge that few efforts have been made to survey the fauna of the region compared with other areas of the state. An important recent contribution is the work conducted by Steven Newman, Ian Potter, Glen Young and Mike Travers on 'Characterisation of the inshore fish assemblages of the Pilbara and Kimberley coasts'. This work is currently accessible in report format only. With regard to other species-specific datasets such as turtles and dugongs, distribution is poorly covered and likely to be at high risk of false-absences. Invertebrates are well represented in Roebuck Bay and Eighty Mile Beach, though data is patchy elsewhere.

Flora - Spatial information on marine flora of the region is almost non-existent. Existing spatial datasets, while terrestrial, are included for the potential contribution they may offer to delineate coastal flora (mangroves). From the available spatial information it would seem that flora represents a considerable gap in knowledge of the marine biodiversity of the region and better spatial information must be derived through further comprehensive surveys together with expert knowledge and non-spatial datasets.

Geoscience - Although the existing marine substrate dataset provides comprehensive coverage across the region, the broad classification (10 types of substrate identified for the whole of Australia) limits its use for delineating substrate heterogeneity at a scale that is useful for planning in the Canning coast region. More detailed data with more substrate classes would be desirable.

Hydrology - Spatial information on divisions, basins and catchments appears adequate. Metadata for the hydrology linear features dataset indicates potential for some missing streamlines. Review of the dataset is needed to determine completeness and accuracy.

Hypsography - Three spatial datasets were identified and suggest comprehensive coverage of the region. Soundings metadata suggests an adequate level of resolution for bathymetry though AUSLIG geomorphic features unlikely to be at a useful scale for planning.

Meteorology - Existing spatial information provides coverage across the planning region for the required datasets and would seem to meet the requirements for marine planning.

Oceanography - Existing spatial information is broad scale and likely to be sufficient to provide background qualitative information on the oceanography of the region. Further review of the datasets is required, though the scale of resolution is unlikely to be sufficiently detailed to determine local hydrodynamics.

Table 8.1. A gap analysis of spatial datasets

Metadata for spatial datasets identified in the audit are assessed against the required datasets for marine reservation and management as derived from Appendix 1 of Hill and Ryan (2002) and the generic framework for the management of spatial data under development by the Marine Information Section (MIS) of the Department of CALM's Marine Conservation Branch. Metadata for all spatial datasets are contained on the accompanying CD.

MIS Category	MIS Class	Status[1]	Dataset Name	Geographic coverage[2]
COASTLINE	coastline	✓	DLI Coastline HWM & LWM	✓
CONTEXTUAL	Air Photos	×	-	×
	Controlled mosaic	✓	DLI Broome Ortho Mosaic 2000	×
	Maps	✓	DoF 5nm Survey Grid	✓
	Landsat images	†	-	
	DMSV (digital imagery)	×	-	×
	Satellite imagery	†	-	
	Video/photographic	×	-	×
ECOSYSTEM	Bioregion	✓	EA IMCRA (1998)	✓
		✓	CSIRO Oceanographic Regionalisation	×
		✓	CSIRO Marine Biological Regionalisation	✓
	Survey	✓	NLWR Terrestrial Biodiversity Assessment 2002	×
	Habitat	✓	CALM Habitat Ground Truth Database	×
		✓	CALM Threatened Ecological Communities	×
	-coral reef	✓	Reefs at Risk Indicator of Estimated Threat	✓
	-seagrass	✓	CAMRIS Seagrass Distribution	×
	-macroalgal	×	-	×
	-mangrove	✓	CALM Mudflats, Mangroves and Rainforest	×
		✓	WA Mangrove Assessment Project 2000	?
	-coastal	✓	Directory of RAMSAR Wetlands	✓
		✓	Australian Estuary Database	✓
		✓	OzEstuaries Database	×
		✓	NOO Estuarine Status Map	×
		✓	GA Coastal Waterways Habitat Mapping	×
	-beach	✓	DPI Broadscale Beach Type	✓
	-intertidal reef	×	-	×
	-intertidal sand	-	See coastal	-
	-subtidal sand	×	-	×
	-deepwater	×	-	×
FAUNA		✓	Australian Biological Resources Study	×
		✓	WA Museum Faunabase	×
		✓	CALM Fauna Database	×

[1] Status
✓ denotes where the audit has captured metadata for spatial data
× denotes where the audit failed to identify metadata for spatial data
† not considered

[2] Geographic coverage:
✓ denotes a spatial dataset that provides complete coverage of the planning region
× denotes a spatial dataset that provides incomplete coverage of the planning region

MIS Category	MIS Class	Status[1]	Dataset Name	Geographic coverage[2]
FAUNA		✓	CALM Mammals on Australian Islands	×
		✓	CALM Aquatic Invertebrates and Water Birds	×
		✓	CSIRO Australian National Fish Collection	×
		✓	CSIRO Introduced Marine Pests by IMCRA	✓
		✓	DEH Distribution of Threatened Marine Species by IMCRA	✓
		✓	Distribution of Marine Fish Species Around Australia	×
		✓	EA Leatherback Turtle Distribution	×
		✓	NOO Mammal and Seagrass Distributions	×
		✓	JCU Dugong Density Aerial Survey	×
		✓	Humpback Whale Tagging	✓
		✓	DEH Whale Species Distribution	✓
		✓	CSIRO Shark Tagging Data	×
		✓	CSIRO Prawn Sampling Northern Prawn Fishery	×
FLORA		✓	CALM WA Herbarium Florabase	×
		✓	CALM Rare Flora Database	×
		✓	DOA Vegetation Survey of WA	×
GEOSCIENCE	Substrate	✓	CAMRIS Marine Substrate Database	✓
	Sediment	×	-	×
HYDROLOGY	Water Feature	✓	DOE Hydrology Linear Feature	×
		✓	WRC Divisions, Basins and Catchments	✓
HYPSOGRAPHY		✓	AUSLIG Geomorphic Features 2002	✓
	Height	✓	DPI Broadscale Marine Contours	✓
	Depth	✓	DPI Sounding Data	✓
METEROLOGY	Cyclones	✓	CAMRIS Cyclone Intensity & Frequency	✓
	Air Temperature	✓	CSIRO Mean Annual & Monthly Minimum and Maximum Temperatures	✓
	Rainfall	✓	CSIRO Mean Annual & Monthly Rainfall	✓
	Radiation/evaporation	✓	CSIRO Mean Annual Evaporation Rates	✓

[1] Status
✓ denotes where the audit has captured metadata for spatial data
× denotes where the audit failed to identify metadata for spatial data
† not considered

[2] Geographic coverage:
✓ denotes a spatial dataset that provides complete coverage of the planning region
× denotes a spatial dataset that provides incomplete coverage of the planning region

MIS Category	MIS Class	Status[1]	Dataset Name	Geographic coverage[2]
OCEANOGRAPHY	Sea level/tides	✓	Baseline Sea Level Monitoring	✓
	Waves	✓	CAMRIS Wave Datasets	✓
	Salinity/ocean chemistry	✓	CSIRO Atlas of Regional Seas	✓
		✓	CSIRO Coastal Station Data – Broome	✓
		✓	CAMRIS Oceanographic Database	✓
	Sea temperature/currents	✓	NOAA Sea Surface Temperature Images	✓
		✓	NASA CZCS Composites 1978-1986	✓
		✓	NASA MODIS 8 day mean near-surface measurements	✓
	Flushing studies	×	-	×
SOCIAL *(NB. data shown here, reflects social data that was collected opportunistically and does not reflect a comprehensive review and gap analysis)*	Cultural/ Heritage	✓	DIA Aboriginal Sites Register System	✓
		✓	WA Historic Shipwreck Database	✓
	Administration/tenure	✓	GA Australian Maritime Boundaries 2000	✓
		✓	DOF Aquaculture Leases	✓
		✓	DOF Fisheries License Areas	✓
	Demography	†	-	
	Economics	†	-	
	Infrastructure	†	-	
	Pollutants	†	-	
	Recreation	†	-	
	Other	✓	DOF Commercial Catch Distributions	✓
		✓	DOF Fish Distributions	✓
		✓	DOF Shark Fishing Zone	✓
		✓	DEH Register of the National Estate	✓
		✓	NOO Charter Boat Operators (coastal)	×

8.1. SUMMARY

This project undertook to review the information available to support further assessment of areas identified by the MPRSWG with the view that these areas may at a later stage be more clearly defined. Our focus was on the identification and capture of spatial datasets, as these data represent a significant new body of information that has only been available since the initial MPRSWG assessment was conducted.

While more than 100 spatial datasets have been identified, the utility of these datasets for marine conservation planning is often limited by their incomplete coverage, broad scale of resolution (too uniform over the region of interest), or simply that they were

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✓ denotes where the audit has captured metadata for spatial data
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[2] Geographic coverage:
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not intended to support marine planning decisions. Some clear gaps in knowledge remain and were especially noted for marine habitats (especially subtidal habitats), biological communities (flora and fauna) and species of conservation significance such as turtles and dugongs. Information on species diversity, distribution, population size, breeding or aggregation areas was not readily available. While the existing information available for some areas (i.e. Roebuck Bay) may be regarded as adequate for specific communities (e.g. intertidal invertebrates and shorebirds), this presents a bias in data coverage and quality that can misinform decision-making if not appropriately accounted for.

Generally, we observed that the state of knowledge has advanced, particularly where technology has a key role. Remotely sensed contextual, meteorological and oceanographic data are notable examples. It should however be recognised that the compilation and processing required in preparing this information in a format suitable for use can be prohibitive. Likewise, the considerable body of new information identified from a search of research and monitoring projects and references, is likely to require some additional level of processing if it is to be in a format that supports systematic identification of candidate areas.

This project has successfully implemented a system to manage the different types of information for expedient application to the different planning stages. What is now required is a clear understanding of the timeframe for progressing marine conservation planning in the Canning coast as this will help to determine how best to move forward and ensure the most appropriate use of resources to address current gaps in knowledge. While the gaps in knowledge will no doubt persist to present challenges for marine conservation planning, they should in no way give cause to prevent conservation action being implemented. Instead, they should be duly considered together with other aspects of uncertainty of the planning process to direct the effective use of information for the selection of comprehensive, adequate and representative system of marine conservation reserves.

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