

Kimberley Marine Biophysical Resource Assessment

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1. Scope of project and area of interest

The waters adjacent to the southern Kimberley region have been identified as being of importance for the conservation of marine biodiversity in Western Australia (Marine Parks and Reserves Selection Working Group, 1994). A preliminary review undertaken by the MPRSWG identified a number of areas that were recommended for inclusion into the State's system of marine conservation reserves. Prior to any marine conservation planning process commencing, an assessment of the available environmental and biological data is required.

The scope of this project was to determine what marine environmental and biological data are available for the Western Australian state waters bounded by the Canning and Eighty Mile Beach bioregions, as defined by the Interim Marine and Coastal Regionalisation for Australia (Australian and New Zealand Environment and Conservation Council, 1998), with particular focus of the areas recommended for reservation by the Marine Parks and Reserves Selection Working Group (1994). Specifically, the data were collected following the ecological criteria outlined by Hill and Ryan (2002). In addition, any opportunistic data on pressures or threats was to be documented.

2. Resources consulted

To determine the available data and literature on the biophysical features of the area of interest, a number of sources were consulted. These were: Library and Information Service of Western Australia; Western Australian Land Information System Interrogator (incorporating the Australian Spatial Data Directory); Western Australian Museum; university and government libraries (including Western Australian Museum library); CSIRO Marine Laboratories Information Network (MarLIN); Australian Natural Resources Data Library; Australian Natural Resources Atlas; online data directory of the National Oceans Office (Neptune); Western Australian Department of Environment (incorporating the Water and Rivers Commission); Western Australian Department of Conservation and Land Management's Florabase; Environmental Protection Authority; the Commonwealth Department of Environment and Heritage's Environmental Resources Information Network (ERIN); Wiley Interscience journal database; ISI Web of Science; internet search engines (particularly Google Scholar); and a range of personal contacts.

3. Results

All information collected was entered into an Access database or into an Endnote library, both of which are included with this report. A synopsis of the findings is presented below. Numbers in parentheses refer to the Access database identification number.

3.1. General information

A number of general studies provided information on a range of physical and biological features of the coastal region. These reports are either in the form of management plans (Curry and Hesp, 1985; Chalmers, 1986; Chalmers and Woods,

1987; Woods, 1988) or are supporting documentation for the recognition of areas of national importance (Livesey, 1993; Watkins, 1993; Livesey, 1994; Livesey et al., 1994). The majority of these reports are based on limited geographic locations around Broome, Roebuck Bay and Eighty Mile Beach.

Also of interest, although outside the scope of this project, is the Western Australian Museum's Shipwreck database (database entry #70), which has all known information on all shipwrecks that occurred in Western Australian waters since 1662. This database is searchable by region, with significant numbers of shipwrecks occurring in the region of interest.

3.2. Geology and geomorphology

Three entries in the database relate to the geology and geomorphology of the region, the geomorphic features of the Australian Exclusive Economic Zone for bioregionalisation of the seabed (#37), the cadastral coastline, sourced from the Department of Land Administration (#22) and the Coast Beach Type dataset (#69) held by the Department of Planning and Infrastructure. Further information is contained in Forman and Wales (1981), Lohn (1984), Semeniuk (1995), van Kranendonk et al. (2002), and Wright (1964).

3.3. Drainage and groundwater

The best sources of data for estuaries, groundwater and drainage basins are the OzEstuaries Database (www.ozestuaries.org) (#35) and the Australian Wetlands Database (#48). The OzEstuaries Database rates all Australian estuaries based on condition assessments. All the estuaries in the region of interest are either nearly pristine or largely unmodified. The Australian Wetlands Database (database reference #48) contains information on all Ramsar (Roebuck Bay and Eighty Mile Beach) and national importance wetlands in the region (Willie Creek Wetlands, Roebuck Plains System, Mermaid Reef, Eighty Mile Beach System and Bunda-Bunda Mound Springs). The information for each entry in the database encompasses physical features, ecological features, noteworthy flora and fauna, social/cultural values, threats and management measures, plus an outline of scientific research in the area and a bibliography. This information is more detailed for the Ramsar sites than for the nationally important wetlands. There is also further information contained in the Western Australian Waters and Rivers Commission database of drainage divisions, basins and water catchment boundaries (#59) and in the general references listed previously in Section 3.1.

3.4. Climate

Basic information on the climate of the region is contained in the general references listed in Section 3.1. A climatic survey of the northwest region was carried out in the early 1970s (Bureau of Meteorology, 1972). The database contains links to a cyclone intensity and frequency index (#36), mean annual and monthly minimum and maximum temperatures, averaged from 1980 to 1999 (#32 & 33), annual and monthly potential evaporation (#49), and annual and monthly rainfall (#50).

3.5. Oceanography

A significant amount of information was found on the oceanography of the region and documented in the database, including coastal zone colour scanner composite mean-monthly maps for the Australian Exclusive Economic Zone (#10), hydrology data from CSIRO cruises (#2, 3, 4), oceanographic regionalisation (#13), CSIRO Atlas of Regional Seas maps and database of temperature, salinity, dissolved oxygen, nitrate, phosphate and silicate (#14 and #52), Broome coastal station oceanographic data (#15), sea surface temperature images/animation (#16, #57), sea surface temperature composite images (#17), CSIRO Connectivity Interface (#18), MODIS chlorophyll images (#19), mean significant wave height and 100 year mean significant wave data (#45) and Australian sea level monitoring data (#51). Further information was found in Holloway (2001), Cresswell and Badcock (2000), and Carew and Hickey (2000).

3.6. Ecological communities

Information on ecological communities was fairly limited, with the majority of the information being on specific taxa (documented in the following sections on flora and fauna). The data sources entered into the database were the Interim Marine and Coastal Regionalisation of Australia information (#24), the Department of Conservation and Land Management marine benthic habitat groundtruthing sites (#25), the distribution of threatened flora and fauna (#40) and the Reefs at Risk database (#38).

3.7. Marine fauna

Information was found on mammals, birds, reptiles, fishes, invertebrates and marine pests in both published literature and in other sources. The Western Australian Museum has a database of all fauna specimens held by the Western Australia, Northern Territory and Queensland museums (FaunaBase: <http://www.museum.wa.gov.au/faunabase/prod/index.html>, #71-77). This database contains records on mammals, birds, fishes, reptiles, crustaceans, molluscs and other marine invertebrates, in varying levels of completion. However, for marine conservation planning these datasets are not particularly useful as they only contain museum specimen records, not the actual distribution of the species. The Australian Biological Resources Study has published the *Zoological Catalogue of Australia*, which contains taxonomic information and broad distributional data on all Australian fauna. The catalogues are not complete, but have been incorporated into the Australian Faunal Directory (#79) which is in the public domain and is freely accessible through the Department of Environment and Heritage. The Australian Faunal Directory is only 70% complete and, as yet, fish data has not been incorporated. The *Zoological Catalogue of Australia Pisces* is in the process of being updated (Hoesle et al., in press; Paxton et al., in press).

3.7.1. Mammals

Data on the distribution and abundance, plus the location of important habitat and breeding localities of dugongs were found (#29 and #47), plus further information contained in Marsh et al. (1999), Marsh et al. (2001) and Prince (1986). The metadata on the known migration pathways and aggregation areas of blue, humpback and southern right whales (#42) and the location and estimated period of humpback whale

activity in Western Australia (#28) were entered into the database. Further information on cetaceans was contained in a range of published literature (Bannister, 1994; Jenner and Jenner, 1994; Jenner et al., 2001; de Boer et al., 2003).

3.7.2. *Birds (shorebirds and seabirds)*

Metadata on seabird breeding islands of Western Australia (#27) were entered into the database and there is extensive published information on birds in this area due to the importance of Roebuck Bay and Eighty Mile Beach for shorebirds, and work carried out by the Wader Group and Birds Australia in association with the Broome Bird Observatory (Storr, 1980, 1984; Lane and Jessop, 1985; Johnstone, 1990; Woinarski, 1992; Livesey, 1993; Watkins, 1993; Tulp and DeGoeij, 1994; Collins, 1995; Franklin and Noske, 2000; Barrett et al., 2003; Hickey et al., 2003; Lambert and Elix, 2004).

3.7.3. *Reptiles*

Metadata on Leathery turtle distributions (#39), Green Turtle nesting sites (#31), and Loggerhead Turtle nesting sites (#30) were entered into the database and further information can be found in Prince (1994) and Woinarski (1992).

3.7.4. *Fishes*

The metadata were documented for the Western Australian Department of Fisheries licence areas for all fisheries active in the region (#66), the distribution of WA Fisheries targeted species (#67), CSIRO cruises BIODATA database in Hobart (#6), northern pelagic shark tagging data (#8), marine fish distributions around Australia (#9), and Commonwealth pelagic longline fisheries data (#21). Further information is contained in various published sources (McKenzie, 1983; Morgan, 1992; Watkins, 1993; Hutchins, 1999; Newman and Dunk, 2002; Ovenden et al., 2002; Hutchins, 2003; Newman and Dunk, 2003; Hoese et al., in press; Paxton et al., in press).

3.7.5. *Invertebrates*

The only metadata available for invertebrates for the region were on commercial prawn catch data of the Northern Prawn Trawl Fishery (#11 and #12). Various studies have been carried out at Roebuck Bay and Eighty Mile Beach on the benthic invertebrate fauna, particularly in relation to the diet of the wader bird populations (McKenzie, 1983; Curry and Hesp, 1985; Watkins, 1993; Piersma and Watkins, 1997; Pepping et al., 1999; Piersma et al., 1999; Piersma et al., 2002; de Goeij et al., 2003; Hickey et al., 2003; Wade, 2004; Storey et al., current). A Western Australian Museum survey documented some of the invertebrates in the region (Morgan, 1992) and some work has also been done on sponges in the region (Hooper et al., 2002).

3.7.6. *Marine pests*

Introduced marine pests per IMCRA region have been determined by the CSIRO and the National Oceans Office and the metadata on this have been included in the database (#41). This was the only data found on the pressures and threats to the marine environment of the region.

3.8. Marine flora, protists and bacteria

Some information on marine flora is available via the Western Australian Herbarium's Florabase (<http://florabase.calm.gov.au>, #78). However, this information (like that contained in Faunabase) is restricted to museum specimen records only and provides no distributional data. It is also limited for marine species.

3.8.1. Seagrass

Metadata on the distribution of seagrasses around Australia (#44) and the relationship between seagrasses and selected marine mammals (#43) were added to the database. Some information is also contained in Kirkman (1997) and in the general references mentioned earlier.

3.8.2. Mangroves

The Western Australian Mangrove Assessment Project 1999-2000 (Pedretti and Paling, 2001) (#46) and the mangrove mudflat and rainforest dataset held by the Department of Conservation and Land Management (#68) documented the distribution and abundance of mangroves around the Western Australian coastline. Further information is also contained in Bridgewater and Cresswell (1999), Carr and Livesy (1996) and Johnstone (1990) and in the general references listed previously.

3.9. Coastal terrestrial biota

The general references listed earlier all contain information on coastal biota, mainly of the plant assemblages and management strategies. In addition a range of metadata was added to the database including information on the Australian Terrestrial Biodiversity Assessment (#34), aquatic invertebrates, water birds and water chemistry of Western Australian wetlands (#53), the populations of mammals (native and exotic) on Australian islands (#54), Western Australian threatened ecological communities (#55), Western Australian rare flora populations (#56), vegetation surveys in Western Australia (#58), the distribution of mangroves, mudflats and rainforest in the Kimberley (#68) and the Western Australian Herbarium's Florabase (#78). Further information can also be found in Beard (1975; 1979), Craig et al. (1983), Craig (1997), Franklin and Noske (2000), McKenzie (1983) and Woinarski (1992).

4. Conclusion

There were significant amounts of data uncovered for the region of interest. However, these data were patchy in nature, with varying levels of spatial and taxonomic resolution. Most of the information was either of broad spatial scale or for the immediate regions around Roebuck Bay and Eighty Mile Beach. The strong focus on Roebuck Bay and Eighty Mile beach is likely due to their importance for waders and migratory birds. Little information was available for the Dampier Peninsular. Further information would be required on all fields if they are to be used for the marine conservation planning process, although the data gathering should concentrate on filling in the gaps in the existing data.

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Appendix 1: Table outlining the metadata entries (dataset ID, dataset name and brief description of the dataset), which are contained in the accompanying Access database

Dataset ID	Dataset Name	Brief description
1	nasa01	MODIS bushfire images
2	Courageous_hydrology	Courageous Cruises processed hydrology data
3	Soela_hydrology	Soela Cruises processed hydrology data
4	Franklin_hydrology	Franklin Cruises processed hydrology data
6	BIODATA_CSIRO	Database of biological data from CSIRO cruises
8	Pelagic shark_tagging	CSIRO tagging and recapture data of pelagic sharks off northern Australia
9	Fish_distributions	Distributions of marine fish species around Australia
10	CZCS_monthly means	Coastal Zone Colour Scanner composited mean-monthly maps for the Australian EEZ
11	Prawn catch_sampling	Commercial catch composition 1988-1990 Northern Prawn Trawl Fishery, also turtle bycatch 1989
12	Banana Prawn_catch	Size sampling of Northern Banana Prawn Fishery 1983-1986
13	Ocean regions_1996	Oceanographic regionalisation for Australia
14	CARS2000	CSIRO Atlas of Regional Seas seasonal oceanographic maps
15	BCDS1997	Broome 40m coastal station oceanographic data, 1977
16	ANIM-SST	Sea surface temperature animations from AVHRR data 1990-1996
17	SST_composites	Sea surface temperature in 1, 3, 6, 10 and 15 day composite images
18	NWSJEMS ConnIe	North West Shelf connectivity interface
19	MODIS_OC	MODIS ocean colour 8 day mean images
21	CPLFD	Commonwealth pelagic longline fishery data 1995-1999
22	Cadastral_coast	DOLA's best available coastline
24	IMCRA	Interim Marine and Coastal Regionalisation of Australia
25	Habitat ground truthing	Marine benthic ground truthing sites in WA collected by CALM

Dataset ID	Dataset Name	Brief description
26	fieldtrip_fisheries_2002	Video and still images collected during a Fisheries WA cruise 2002
27	seabird-breeding-islands-wa-01031999_amg50_agd84	WA CALM seabird breeding islands database
28	Humpback Activity.pdf	Location and period of humpback whale activity in WA
29	dugptll.shp	Habitat and breeding locations for dugongs in WA
30	nlnest-Loggerhead Turtle Nesting Sites	Point locations of Loggerhead Turtle nesting sites
31	ngnest-Green Turtle Nesting Sites	Point locations of Green Turtle nesting sites
32	Min_temp	Mean annual and monthly minimum daily surface temp 1980-1999
33	Max_temp	Mean annual and monthly maximum daily surface temp 1980-1999
34	ATBA_2002	Australian Terrestrial Biodiversity Assessment
35	Estuary Assessment 2000	Condition assessment and classification of all Australian estuaries
36	CIFI	Cyclone Intensity & Frequency Index, maps and data
37	Geomorphic_EEZ	Dataset of geomorphic features of the seafloor of the Australian EEZ
38	Reefs at Risk	Global assessment of anthropogenic threats to coral reefs
39	Leathery Turtle_distributions	Distribution of Leathery Turtle in Australian waters, from Environment Australia
40	TFF_distribution	Distribution of threatened flora and fauna in Australia
41	Marine pests_IMCRA	Total numbers of introduced marine pests per IMCRA region
42	Whale_distributions	Migration pathways and aggregation areas of blue, southern right and humpback whales
43	Map_seagrass_selected mammals	Distribution of selected mammals and seagrasses in North West Planning Region
44	CAMRIS_seagrasses	Distribution of seagrasses around the Australian coastline
45	CAMRIS_GEOSAT wave	Data derived from the GEOSAT satellite radio altimeter wave measuring program
46	WA_mangrove assessment	Information and site descriptions of all mangrove communities in WA
47	Sylvia_Adam_dugong	Density and distribution data of dugongs and turtles from Broome to NT border

Dataset ID	Dataset Name	Brief description
48	Australian Wetlands Database	DEH online database of biophysical information for all Ramsar and nationally important wetlands
49	Potential_evaporation	Calculated annual and monthly potential evaporation
50	Annual & monthly rainfall	Mean annual and monthly rainfall 1980-1999
51	Sealevel_monitoring_project	Australian Baseline Sea Level Monitoring Project – designed to identify long term sea level changes. One monitoring station in the study area (Broome)
52	AROD	Australian Region Oceanography Database (an archive of vertical profiles of temperature, salinity, oxygen and nutrients taken around the entire Australian coastline)
53	Aquatic inverts_waterbirds_waterchemistry	Database of Western Australian wetlands and rivers documenting aquatic invertebrates, water birds and water chemistry
54	Mammals on islands	Records of native and exotic mammals on Australian islands
55	Threatened ecological communities	Dataset containing information on the location and composition of all threatened ecological communities throughout Western Australia
56	Rare flora populations	Information on the population, location, habitat, biology and management of threatened floral species in Western Australia
57	SST_imagery	Processed satellite data showing sea surface temperatures, derived from NOAA AVHRR data
58	Vegetation survey of WA	WA vegetation survey incorporating plant formations and associations, classification, plant geography and vegetation systems
59	Drainage divisions	The drainage divisions, basins and water catchment boundaries of WA defined at varying scales
66	Fisheries datasets	Polygon coverage for all Fisheries WA licence areas active in Western Australia
67	Distribution of target species	Polygon coverage of the distribution areas for Fisheries WA targeted species
68	Mudflats_mangroves_rainforest	Raster data of locations of mangroves, mudflats and rainforest in the Kimberley region (primarily northern Kimberley, although part of the Dampier Peninsular is included)

Dataset ID	Dataset Name	Brief description
69	WA beach types	Geomorphology of WA beaches
70	WA Shipwreck database	Database of all available information of shipwrecks in WA waters from 1662
71	WA_fauna_birds	Part of Department of Conservation and Land Management's Florabase
72	WA_fauna_crustaceans	Part of Department of Conservation and Land Management's Florabase
73	WA_fauna_reptiles	Part of Department of Conservation and Land Management's Florabase
74	WA_fauna_fish	Part of Department of Conservation and Land Management's Florabase
75	WA_fauna_mammals	Part of Department of Conservation and Land Management's Florabase
76	WA_fauna_marine invertebrates	Part of Department of Conservation and Land Management's Florabase
77	WA_fauna_molluscs	Part of Department of Conservation and Land Management's Florabase
78	Florabase	Western Australian Herbarium's Florabase – website containing information on plants found in WA
79	ABRS	Australian Faunal Directory published by the Australian Biological Resources Study

Addendum to Kimberley Marine Biophysical Resource Assessment

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2. Resources consulted cont.

The resources were searched in a variety of ways, dependent on the format of each specific resource (Table 1). Temporal limits were not set in any of the searches, as all data available for the region were of interest. Spatial limits were set for some of the searches, in which case they were the same for all searches (N -16°, S -20°, W 119°, E 123°), determined as being the approximate geographic coordinates for the extent of the region of interest. If the dataset extended beyond this boundary it was still included and the geographic extent recorded in the Access database. Topic/keyword limits were determined according to the format of the database/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, Table 1). The state and federal government department websites were searched manually to find any relevant data or references. Any available references found through government departments or libraries were checked to determine if they contained any other relevant references, prior to being entered into the Endnote library.

Table 1: The resources consulted during the Kimberley Marine Biophysical Resource Assessment plus the temporal and spatial limits and the topic/keywords used in the searches.

Resource	Topics/keywords	Temporal limits	Spatial limits
Libraries (LISWA, universities)	80 Mile Beach, Broome, Kimberley, marine, biology, habitats	None	None
Journal databases (Wiley Interscience and ISI Web of Science)	Western Australia/north AND: Geology/geomorphology Drainage/groundwater Currents/oceanography/tides/waves Marine flora/fauna Coastal/marine habitat Dugong/whale/turtle/mammals/fish Seagrass/mangroves	None	All searches were limited by including Western Australia AND north as a keyword
State and federal government department websites	Manually searched through to find any relevant data	None	None
MarLIN	None	None	N -16° S -20° W 119° E 123°
Neptune	None	None	N -16° S -20° W 119° E 123°
Australian Natural Resources Data Library/Atlas	Marine, climate and weather, ecology, fauna, fisheries, flora, oceanography,	None	None
WALIS Interrogator	Climate and weather, ecology, flora, fisheries, fauna, marine, oceanography, vegetation, water	None	Defined on map provided – area defined larger than area of interest to ensure all relevant resources were obtained