WAMSI Progress report to 30 June 2007 for WAMSI Node 3 Project 4 (WAMSI Code 3.4):

Ningaloo Marine Park Offshore Geomorphology, Surficial Sediments and Habitat Linkages

Executive Summary

The characterisation and conservation of benthic habitats and communities based on physical factors is central in the ongoing monitoring and management of the Ningaloo Marine Park (NMP). Physical factors including geomorphology, sediment composition (texture, mineralogy and constituents), mobility of the substrate, bathymetry, the hardness and roughness texture of the seabed and water depth, can be significant in describing the distribution of benthic biota and habitat types over broad geographic regions.

The main goal of this study is to improve the understanding of the character of the geomorphology and surficial deposits of the Ningaloo continental shelf. This report covers part of Objective 1 and 2 in WAMSI Node 3 Project 3.4. The project will focus on mapping the seafloor with acoustics (multibeam, singlebeam and sidescan sonar) and collecting georeferenced video data, sediment grabs and dredged rock samples to verify acoustic interpretations. The relationships determined at this scale may be used to inform our understanding of benthic habitat variability across the whole Marine Park. Known relationships will be extrapolated to the broader area to aid in the production of broadscale habitat maps of the Ningaloo Marine Park (NMP) as part of WAMSI Node 3 Project 3.1.1.

The NMP lies across the boundary of the Northern and Southern Carnarvon Basins with the majority located in the Exmouth Sub-Basin of the Northern Carnarvon Basin. This large Palaeozoic-Recent mainly offshore basin, on the Northwest Shelf, is Australia's premier hydrocarbon province. The Tertiary Cape Range Anticline is one of the dominant features of the terrestrial landscape of the Exmouth Sub-Basin and the Muiron Islands, to the north-east, are recognised as extensions of the anticline. The NMP extends 260km from Northwest Cape to Amherst Point encompassing most of the Ningaloo Reef. The continental shelf is gently sloping underlain by Pleistocene limestone with a veneer of marine sediments and interrupting this shelf, a fringing reef system. The location and morphology of the reef environments has a critical relationship with the oceanography within and surrounding the Marine Park and the complex intertidal and subtidal geomorphology plays a significant role in the variety of marine habitat types and correspondingly high species diversity.

This research presents an interdisciplinary study through the use of a Geographic Information System (GIS) and seabed mapping techniques, using acoustics, traditional sedimentological sampling and towed video. In 2006/2007 the Australian Institute of Marine Science (AIMS), in conjunction with Fugro Survey Pty Ltd (FUGRO), the Western Australian Museum, and students from the University of Western Australia (UWA) and Curtin University of Technology (CUT), initiated surveys in the northern part of the NMP to develop broadscale habitat maps of the deepwater component of the reserves (offshore of the fringing reef).

Broadscale bathymetry of the continental shelf adjacent to the northern part of NMP was examined prior to the survey. 3D bathymetric models created from faircopy nautical charts, supplied under license by the Australian Hydrographic Office of the Royal Australian Navy (RAN), and a fine scale multibeam hydro acoustic survey carried out by Fugro Survey Pty Ltd (FUGRO) were the primary tools used prior to this survey to identify areas of bathymetric, topographical, benthic and piscatorial interest in areas with different levels of conservation protection. A singlebeam hydro acoustic survey carried out by the Centre of Marine Science and Technology (CMST) at Curtin University of Technology was used to gather data during the survey to identify areas of interest for sampling. A towed video system and benthic sled were used to

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sample the biodiversity, diversity and abundance of filter feeding communities and invertebrate diversity and abundance. Single and multibeam acoustic surveys and sediment grabs were used to investigate and sample surficial sediments and seabed geomorphology of the deeper waters of NMP.

Acoustics combined with sedimentological and geomorphological data enabled the characterisation of different habitats according to depth, topography, substrate stability, hardness and roughness, grain size and suitability to support significant biota, from the base of the fore reef slope to the edge of the continental shelf. The shelf within the northern NMP is narrow and preliminary results show a clear zonation of habitats across the shelf. There is a strong association between geomorphology and benthic habitats with communities taking advantage of the availability of Last Interglacial (LI, ca. 125 ka) substrates composed of fossilised limestone. The hardbottom is mainly composed of a fossilised limestone reef surface, karstified in places due to glacial lowstand subaerial exposure. In the shallow reef slope zone, a thin veneer of Holocene coralgal growth is largely determined by the antecedent LI topography. Between 30-40 mwd, even where hard substrates are still available, hard corals rapidly disappear, gradually replaced by a mixed deep-water benthic community. This transition, between the base of the fore reef slope and the inner shelf is characterised by reef and rhodolith gravel that supply the hard substrate for a diverse community dominated by crinoids, sponges, turf algae and *Halimeda*, with minor soft corals (gorgonians, sea whips), ascidians, and sea pens.

There is an extensive middle shelf sand plain where sediment thickness is variable overlying limestone pavement and low relief ridge systems. Here communities of sponges, crinoids, sea pens, sea whips and hydroids are patchy with higher abundance associated to exposed LI substrates. Bioturbation was evident from echinoderm feeding traces, polychaetes and burrowing fish and a diverse infauna have reworked the sediments to build mounds and burrows. A number of ridges have been identified at various depths with prominent and extensive systems on the outer shelf (75-125 m). Exposed limestone substrates are colonised with high cover of exotic sponge and gorgonian gardens, some of which are likely to be new species. Diversity is particularly high in areas adjacent to the continental slope canyons which are thought to bring nutrients to the shelf edge. A more complex history of constructional and pre-existing antecedent topography exists at Cloates SZ, where Tertiary limestone surfaces, paleo stillstand escarpments and shorelines, and stepwise LI fossil reefs, support a diverse coralgal and sponge community. Here corals persist to greater depths (40-50m) than those observed in the NMP.

The importance of calcium carbonate secreting organisms to the surficial sediments is evident. Grains are almost wholly biogenic in origin consisting of older relict and reworked grains mixed with modern skeletal fragments. Depth consistent sediment facies can be recognised on the basis of component composition. Inner shelf sediments are dominated by hardground/rhodolith/coralline algal gravelly sands, modern skeletal rippled sands transported in submarine fans adjacent to reef passes, modern skeletal gravelly shelf sands dominated by a mixture of coralgal, mulluscan, foraminiferal and bryozoan components and seagrass/sublittoral fine sands. Grains composing whole skeletons or fragments, and gravel sized clasts are heavily encrusted by coralline algae. Middle shelf sediment is dominated by foraminiferal dominated relict skeletal sands, with initial observations indicating modern counterparts in shallower water depths suggesting deposition during lower sea-level in the Pleistocene. Subphotic sediments on the outer shelf and upper slope are a mixture of modern cool-water, poorly sorted, bryozoan/molluscan dominated gravelly muddy sands with small benthic and planktonic forminifera, sponge spicules and brachiopods. Relict grains again are common.