NATIONAL OCEANS OFFICE

National Work Program (Torres Strait)

Torres Strait Seabed & Water-Column Data Collation, Bio-physical Modeling and Characterization

Project Number: NOOC2003/010

Roland Pitcher, Scott Condie, Nick Ellis, Ian McLeod, Mick Haywood, Scott Gordon, Tim Skewes, Jeff Dunn, Darren Dennis, Liz Cotterell, Malcolm Austin, Bill Venables, Tom Taranto

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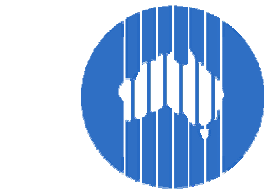

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NATIONAL OCEANS OFFICE National Work Program (Torres Strait) Final Report

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EXECUTIVE SUMMARY

The main aims of this project were to compile and assess the current state of knowledge of the broad-scale seabed and water-column ecosystem of Torres Strait, provide a preliminary characterisation of the region for use by the National Oceans Office (NOO), and design a sampling strategy for the Ecosystem Mapping Task of the Cooperative Research Centre for the Torres Strait. The project successfully collated and assessed relevant seabed & water-column data-sets, examined relationships between the biological and physical data, developed a bio-physical stratification of the seabed for the Torres Strait region, and completed a sampling design for the mapping project in time for the first field survey in January 2003. The major beneficiaries of the information include the National Oceans Office (NOO) and the Torres Strait people, and the Australian Fisheries Management Authority (AFMA) and the Torres Strait fishing industries. Funding was provided by the NOO and CSIRO.

Significant information on the physical environment was available from existing data. The Project collated 17 major datasets of physical and biological data for the region. Available relevant information included: physical environment (bathymetry, sediment grain-size and composition, water attributes & chemistry, ocean colour); basic seabed habitats; seagrass and algae; and some trawl samples. After checking quality and redundancy among sources, 32 physical variables were identified and mapped as potentially useful for modelling & stratification. A 0.01 degree resolution (~1.1 km) grid was established for analyses and sampling design, and the physical variables were re-sampled to this grid and mapped (interpolated where required), to provide a consistent set of full-coverage covariates at ~45,000 grid cells for the Project. The biological data was sourced from multiple legacy projects, each with different objectives, and was reconciled to useable common-denominator formats.

The broad-scale physical factors important in structuring patterns in the biological data were identified. Seabed current stress was the most important variable, and others included: chlorophyll, turbidity, oxygen, salinity, nutrients, sediment grain size, and depth. These bio-physical relationships were used to predict and map the categorical biological data to the whole Torres Strait region, with an estimate of the uncertainty. The Torres Strait region was characterised by weighting each physical covariate by its biological importance, then grouping the 0.01° grid cells into strata that had similar physical attributes. The stratification was mapped and represents an interim surrogate characterisation of Torres Strait. Sites for future sampling by the CRC-TS Mapping Task were selected from the bio-physical strata to provide representative coverage of the Torres Strait environment.

The Project described the current state of knowledge of the physical marine environment and the seabed habitats and biota, identified the major knowledge gaps and the key information needs for regional marine planning and ecosystem-based management. These are summarized here.

Torres Strait is a shallow area of continental shelf with complex topography comprising numerous reefs and islands; the eastern area includes deeper water but is more complex; the northwestern area is very shallow limiting navigation. For navigation reasons, the bathymetry of the main shipping channels is well known, but much of the region has not been surveyed and is poorly known. Consistent coverage of bathymetric data over Torres Strait, at resolution sufficient for navigation purposes, is required for reliable circulation modelling and bio-physical mapping.

Tides and currents dominate the physical oceanography of Torres Strait, with strong tidal currents in channels between reefs. Quantitative knowledge of tides and currents is largely from the output of models, as there are few tidal and current monitoring stations. The tides and currents in most of Torres

Strait have not been measured, leading to model uncertainty and lack of knowledge of the broader circulation, dispersion and connectivity. Additional tidal and current monitoring stations are needed at key locations and periods across Torres Strait to provide data to validate circulation models.

Limited knowledge of basic hydrographic conditions indicates that: water temperature peaks broadly over the summer and during winter, shallow areas are cooler; salinities fall during the monsoon season, when a low salinity feature occurs along the PNG coastline, and increase again during the dry season; strong tidal mixing generally prevents vertical stratification and oxygen levels are relatively high in the well-mixed water; nutrients may increase during the monsoon and decrease during the trade wind season, consistent with riverine inputs; and limited time-series data indicate inter-annual variability in the monsoonal and trade-wind influences. The coverage of basic hydrographic data is extremely sparse, both spatially and temporally, and there is a critical need for additional moorings to be deployed at key locations, to provide knowledge of interannual variability and environmental change and to develop any understanding of productivity processes in Torres Strait.

Sediments become suspended by the strong spring tide cycles and wind stress, particularly in shallow areas and near rivers, causing local areas of high turbidity. Turbidity has been estimated from the SeaWiFS satellite data but is confounded in shallow areas like Torres Strait. Very few direct measurements have been made and knowledge of their tidal and seasonal patterns is inadequate. Measurements of suspended sediments are required at key locations and spanning spring-neap tidal and seasonal cycles.

There is little knowledge of biogeochemical cycles in Torres Strait, or of the role of suspended sediments in those processes, and studies *de novo* are required.

The phytoplankton in Torres Strait is not known from any direct measurements and estimates based on satellite ocean colour are confounded by turbidity and shallow water. Nevertheless, indications are that chlorophyll levels are higher during the monsoon season and decrease towards winter. The primary productivity processes and plankton community structure in Torres Strait are unknown, and again studies *de novo* are required.

The seabed sediments of Torres Strait cover the full range from fine terrestrial muds near rivers to coarse carbonate sands and gravels among coral reefs further from land. Over that pattern, the strong tidal currents scour fine sediments from narrow channels, leaving coarse gravels and rocks, and deposit them in calmer areas. The currents also create and move dunes of sand. However, the sediment grain size attributes of most of Torres Strait have been sampled only patchily and there are extensive gaps in east/southeastern and northwestern Torres Strait. Sediment types typically showed little similarity over distances of more than 5 km, perhaps 10 km maximum, providing a criterion (spatial autocorrelation) for assessing that the existing coverages were inadequate for significant parts of the region. Adequate fine-scale sampling of sediment grain size and composition is required for understanding sediment processes and biogeochemical cycles, and as surrogates for biological assemblage prediction. Sediment organic content is almost unknown, but would also contribute to these knowledge needs. Acoustic data from several vessel tracks was shown to be a useful surrogate for seabed substratum and can provide continuous along-track coverage between actual sediment samples.

Prawn trawling is largely confined to a relatively narrow strip in central eastern Torres Strait and extremely intense effort was aggregated into an area of about 200 km². The trawl logbook data

coverage is quite complete; however, the resolution is coarse compared with actual trawling activities. Fine-scale trawl effort data needs to be acquired from Vessel Monitoring Systems installed on Torres Strait trawlers to provide effort data at a resolution needed to assess and manage the environmental sustainability of trawling.

The basic seabed habitats of Torres Strait (substratum type, megabenthos gardens, presence of algae and seagrass) are relatively well known compared with many other areas of seabed within Australia. The region has significant large areas of structured habitat and benthic gardens, as well as extensive seagrass beds and algae. From this knowledge, it has been observed that seabed current stress appears to be very important in structuring habitat patterns, as are sediment attributes. Moving sediments may smother benthic habitat and expose bare substratum for colonisation. Sediment dynamics may also be involved in seagrass diebacks in north west Torres Strait, though the causes are unknown.

The broad habitat characterisation is known for about two-thirds of the region, at a resolution comparable with the spatial autocorrelation distance for habitat similarity (ie. ~10 km). Unknown areas include extensive areas of north-eastern and western Torres Strait. While, this broad information has been useful, it is inadequate to properly characterize biodiversity assemblage, to develop bio-physical models and for quantitative management applications. For these purposes, species biomass data are required but are largely unavailable in Torres Strait. Where more detailed biological information is available for some biota, the spatial coverage is very limited. Thus, a broad spectrum of seabed species need to be sampled in Torres Strait, accurately identified, quantified and mapped. Careful species identification is essential because Torres Strait is a biogeographic boundary due to past periodic separation of east & west faunas — an important concern for regional marine planning.

There is also very little knowledge of assemblage dynamics or of ecosystem processes in Torres Strait. Primary productivity, whether benthic or planktonic, has not been studied in Torres Strait nor have secondary productivity and higher trophic relationships, other inter-species inter-actions, or coupling between the benthic and pelagic ecosystems. This kind of ecosystem-level knowledge is required in order to progress towards ecosystem-based management of multiple uses of the Torres Strait marine environment, and needs to be synthesized by dynamic modeling approaches such as Management Strategy Evaluation.

The Torres Strait CRC program will address a number of these data issues at varying levels of detail. Field measurements to be made by the “Bio-Physical” and “Seabed Mapping” Tasks will provide additional hydrographic data and develop hydrodynamic modelling. Data on seabed and suspended sediments will be collected and sediment transport will be modelled; the issue of seagrass dieback will also be examined. Bathymetric data will be collected by research vessels. Data on seabed habitats will be recorded and a broad range of seabed assemblage species will be sampled, identified, quantified and mapped. However, the mapping will not be able to cover the entire region, and the program does not currently include studies of biogeochemical cycles or of biological ecosystem processes.

This Project has provided an essential foundation for several CRC-TS Tasks that will address priority issues related to assessment of the effects of trawling, development of trawl sustainability risk indicators, seagrass dieback, bioregionalisation for marine planning, and multiple-use management. The preliminary characterisation of the Torres Strait region provided by the project will support the planning needs of NOO and other management agencies, in the interim before the results of TS-CRC Tasks become available.

1. INTRODUCTION

1.1. BACKGROUND

There has been an urgent need to complete preparatory work prior to the start of the Torres Strait CRC in July 2003, so that fieldwork for the Task Ecosystem Characterisation may proceed in the required timeframe. This project aimed to collate and assess relevant seabed & water-column data, examine bio-physical relationships, develop a stratification for the Torres Strait and to design a seabed & water column sampling strategy for the TS CRC ecosystem survey task. Other benefits include assessment of the current state of knowledge relevant to this task and provision of a preliminary characterisation of the region for use by the National Oceans Office (NOO). These fundamental datasets and analyses will support present and future research and monitoring needs, conservation planning, and management — ultimately contributing to the preservation of the unique values of this region.

Available relevant information included: physical environment (bathymetry, sediments, water attributes & chemistry, ocean colour); seabed habitats; seagrass; and limited trawl samples. The approach has been to collate & integrate seabed & water-column data from disparate sources to common useable formats, identify any broad-scale physical factors important in structuring patterns in the biological data, characterise and stratify the Torres Strait region based on extension of the bio-physical relationships to the whole region. A cost-effective & optimised sampling strategy needs to be designed to representatively sample the identified bio-physical strata. Information gaps need to be identified in relation to data type, bio-physical strata, prediction uncertainty – as well as spatial grid coverage. Outputs in the form of digital GIS layers will be provided to the NOO.

This Project has assessed the state of knowledge of seabed habitats, seagrasses, benthic biodiversity, and the water-column in the complex ecosystem of the Torres Strait; provided interim spatial characterisation information for management and planning needs until more complete information is available (including issues related to anthropogenic impact in seabed ecosystems eg. trawling); and design future research surveys to optimally & cost-effectively address gaps in the current knowledge. The broad-scale objectives of this Project have been met by specialists from multiple disciplines and experienced Torres Strait researchers, based on CSIRO Marine Research's (CMR) significant Torres Strait data holdings and access to other relevant datasets. The approach is relevant to the national objectives of NOO as outlined by Australia's Oceans Policy.

1.2. NEED

This Project was required to provide an essential foundation for TS-CRC Tasks that will address issues related to seagrass dieback, assessment of the effects of trawling, development of trawl sustainability risk indicators, bioregionalisation for marine planning, and multiple-use management. These issues were identified as priorities at several client and stakeholder forums. The NOO and CMR identified the outputs of this Project as a pre-requisite for the CRC-TS Task Ecosystem Characterisation to proceed from July 2003. Another need to be provided by the Project is an interim characterisation of the Torres Strait region to support the planning processes of NOO and other management agencies, before the results of TS-CRC Tasks become available.