Trophic systems of the North West Marine Region

A report to the
Department of the Environment, Water, Heritage and the Arts
by **CSIRO Marine and Atmospheric Research**

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Important Notice

Table of Contents

List of Figures

List of Tables

1. EXECUTIVE SUMMARY

The Australian Government is in the process of preparing Marine Bioregional Plans for all Commonwealth waters. This report contributes to that process by gathering, reviewing and summarising the best available information to identify and describe the trophic systems, functional groups and relationships, links across systems and physical drivers of the North West Marine Region (NWMR) for use in the North-west Bioregional Profile.

Researchers at the CSIRO Marine and Atmospheric Research (CMAR), with input and review from scientists from The Australian Institute of Marine Science (AIMS), undertook an assessment of the trophic systems of the region to assist The Department of the Environment and Water Resources (DEW) in developing an understanding of the NWMR ecological systems. The restricted timeframe necessitated focussing only on existing information. Close collaboration with DEW staff assisted the process through the provision of literature reviews of physical drivers and species assemblages. The report was compiled with the intention of providing a broad overview of existing information to provide an integrated understanding of the trophic systems of the NWMR and its important features. This report, together with a number of others commissioned or written by DEW, in consultation with various experts and stakeholders, will subsequently be used by DEW in compiling the North West Bioregional Profile.

Our approach to the information compilation was systematic and selective but ultimately constrained by the available information and the time limits of this project. Thus some regions of the NWMR are described in greater detail than others. The information gaps are mostly noted in our descriptions so as to guide future data gathering efforts. The key guiding principle we developed to aid the information compilation was to focus on providing a “systems” view of the NWMR at a range of scales of interest to DEW. We began by developing a conceptual definition of a system and then progressively compiling the information required to implement this definition for the NWMR.

The systems approach we developed required defining firstly a broad set of regional systems that were differentiated by large scale oceanographic drivers. Within this regional set of systems, sub-regions were defined based primarily on differences in processes operating on the continental shelf, the continental slope and the abyssal plains. Important ecological features and specific trophic processes associated with those features provides the finest level of description attempted in this project.

We identified three major systems influencing the NWMR with a small element of a fourth system in the south. The fourth (southern-most) system resulted partly from alignment issues between the definition of the NWMR and natural boundaries of the Indian Ocean Central Watermass – a large high salinity gyre driven by evaporative forcing – that impinges on the NWMR up to about Shark Bay and is a key feature of the South West Marine Region.

The northern portion of the NWMR is driven largely by the oligotrophic Indo-Pacific Throughflow (ITF) which critically affects the productivity of the trophic systems down to about Broome. The deep overlying surface layer of oligotrophic water mass suppresses upwellings and a subsurface maximum in chlorophyll is formed where nutrients and light are sufficient for photosynthesis to proceed. South of this system is a massive oceanic transitional zone that spans almost the width of the Indian Ocean from the North West Shelf across to Africa. We further divided the area under the influence of the transitional zone into two major systems, based largely on the width of the shelf: one from Broome to North West Cape associated with the wide northern shelf and another from North West Cape down to just north of Shark Bay associated with the narrower shelf driven by its closeness to the deep ocean and the beginnings of the Leeuwin Current. Sub-regions and important features within these regional systems were subsequently identified and described to the extent possible in this project. Shelf, slope and abyssal areas are also major ecological determinants and were used to further compartmentalise the region into trophic system sub-regions.

In this report we have described the NWMR as a strongly physically forced system with several key drivers. Energetic physical processes control the delivery of deep nutrient to shallower depths so that the region as a whole is strongly constrained by the intensity and frequency of energetic events, and the intensity of the Indo-Pacific Throughflow. In other words, the dynamics of this region are strongly governed by temporal physical events.

The surface layers of the offshore regions rely upon picoplankton and microbial recycling, while larger diatoms, plankton and copepods rapidly regenerate to use any nutrients that upwell into the photic zone. The shelf regions are highly dependent on physical processes that transport nutrients from the offshore into the bottom of the water column and towards the coast. Coastal regions therefore rely upon recycling processes to support the standing crop of various trophic groups. Detritivores play a key role in the recycling process along with the microbial groups. Energetic events enhance productivity that is rapidly taken up by primary consumers including the important filter feeder groups. Bentho-pelagic groups play a key role in competing for productivity in both the pelagic and benthic sub-systems and in so doing also they facilitate the transfer of productivity between the sub-systems. The trophic systems of the NWMR are highly tuned to utilise productivity wherever it is injected into the photic zone from physical events. These events and background physical processes such as tides and seafloor mixing processes critically control the trophic systems of the region.

The NWMR can be distinguished from the other marine regions around Australia by its unique combination of features. These include a wide continental shelf, very high tidal regimes, very high cyclone incidence, unique current systems and its warm oligotrophic surface waters. It also has a range of unique features including the highly productive Ningaloo reef region, the expansive Exmouth Plateau slope region and offshore reefs. Although there is some connectivity with the North Marine Region (NMR) via larval advection within the Indo-Pacific throughflow, a large proportion of the demersal and benthic fauna in particular are relatively unique to the region. There is some overlap with the NMR in that the WJBG and western extents of the NMR show a high degree of similarity in habitats, communities, and hence their trophic systems. Similarly, the most southern sub-regions (Kalbarrri Shelf and Wallaby Saddle) are probably closer in

character to the SWMR than the NWMR; to the extent that a slight manoeuvring of the boundary edges of these 'edge' regions may make more ecological sense. However, the majority of the NWMR is ecologically unique, as borne out in the limited number of studies that have assessed aspects of these communities in a broad context.

The resilience and vulnerability of trophic systems in the NWMR varies between different sub-regions and more locally between different trophic communities. Some environments are adapted to coping with environmental variability such as the shelf regions in the north of the NWMR, which are subject to highly variable coastal freshwater and nutrient input, highly variable tidal currents and/or sporadic major climate events such as cyclones. These environments are likely to be more resilient to other climatic variability such as variations in seasonal patterns, more frequent or more intense weather patterns. However, their tolerance to increased water temperatures is less certain, and their tolerance to anthropogenic pollution is likely to be low, as demonstrated in marine environments elsewhere.

Other trophic communities appear to be less tolerant of environmental change, such as the offshore coral reefs that are subject to bleaching and high mortality under slightly elevated sea temperatures; or the productive trophic system adjacent to Ningaloo Reef which relies on the seasonal flow of the Ningaloo Current. The continental slope sub-regions have relatively narrow physical tolerances but are adapted to some physical disturbance such as sediment slumping. The deeper communities survive in a relatively narrow range of tolerances. They are removed from many potential sources of impact, but are unlikely to be able to tolerate physical, chemical or environmental changes.

Although this report describes the trophic and ecological systems of the NWMR, it relies on expert knowledge and inference throughout many of the sub-regions. There is an urgent need for greatly improved understanding in many of the regions' habitats in order to adequately manage and conserve its values. The least understood areas include the slope and abyssal sub-regions, and some of the shelf sub-regions. However, within these sub-regions many habitats – including bank and channels, canyons, shoals, islands and pinnacles – are highlighted in this report based on their high ecological value, but are poorly understood. They often have high biodiversity, limited spatial extent and are impacted by fishing or other industry, and as such, the communities and species supported by them may be at risk and require specific protection. The connectivity between habitats and species conservation is also poorly understood and requires further research to adequately protect the species and habitats within the NWMR.

Acknowledgements

Despite the limitations of the project, we have thoroughly enjoyed the scientific challenge presented to us by DEW and we wish to record our sincere appreciation and acknowledgement of the efforts of the DEW team in assisting beyond the call of duty with this project. We also acknowledge the wealth of information compiled by researchers who have worked in this region. While we are unable to fully acknowledge and include the work of these researchers, this project should be viewed as part of a coherent attempt at gaining an integrated understanding of the NWMR. We apologise in advance to those whose work we may have overlooked but trust that they will have the opportunity to provide substantive input in the NWMR planning efforts.

We also thank those who helped produce the report including Donna Bugden and Toni Cannard (project support, report compilation and formatting) and Louise Bell (front cover).

2. INTRODUCTION

The Australian Government is in the process of preparing Marine Bioregional Plans for Commonwealth waters. This is being separately compiled for the South East, South West, North, East and North West Marine Regions. The first step in the planning process involves gathering, reviewing and summarising the best available information for each Marine Region to broadly describe the key drivers, natural processes, habitats, species, heritage values, human uses and benefits of the region. This information will form the Bioregional Profile for that region.

To this end, The Department of the Environment and Water Resources (DEW) is undertaking in-house research and information collation by the NW team at DEW, Hobart, with contributions from a number of contracts to provide scientific expertise on specific aspects of the region. This report delivers information for the NWMR Bioregional Profile by providing an understanding of the trophic systems and the physical drivers of these systems. This includes identifying different trophic systems, their large scale physical drivers, functional groups and relationships, links across systems, resilience and vulnerability of each system, and information gaps.

The NWMR encompasses Commonwealth waters from Kalbarri in the south to the WA/NT border (Figure 3-1). The following sections of the report firstly describe our approach to characterising the trophic systems and the conceptual models and diagrams used throughout, followed by a general description of the NWMR and the drivers that influence and characterise the region. The region is compartmentalised into eleven trophic systems (sub-regions) (Figure 5-3). The key influences on the compartmentalisation process are described, followed by separate descriptions for each of the trophic systems (Sections 6.1-6.11; described as NWMR sub-regions) and a discussion of the general features of the region.

3. OBJECTIVE, KEY QUESTIONS AND ACTIVITIES

The objective of this project is to describe the trophic systems of the NWMR.
The key questions that the study was initially designed to address included:

1. What are the major trophic systems in the region? How do they differ across the region geographically?
2. What are the key physical drivers in the NWMR and how do they result in different trophic systems across the region?
3. How resilient are these systems to change?
4. What are the links between trophic systems within the NWMR?
5. What are the key features of the trophic systems in the NWMR and how do they differ from other marine regions in Australia?

Key activities have included:

1. Completion of a written report summarising the trophic systems for the NWMR, including a documention of gaps in knowledge.
2. Interact, where possible, with relevant experts in compiling the information.
3. Provide DEW with a list of datasets, GIS layers, maps and diagrams used in developing the trophic system descriptions.
4. Incorporate DEW's comments and reviews by selected experts on the draft report into a final report.

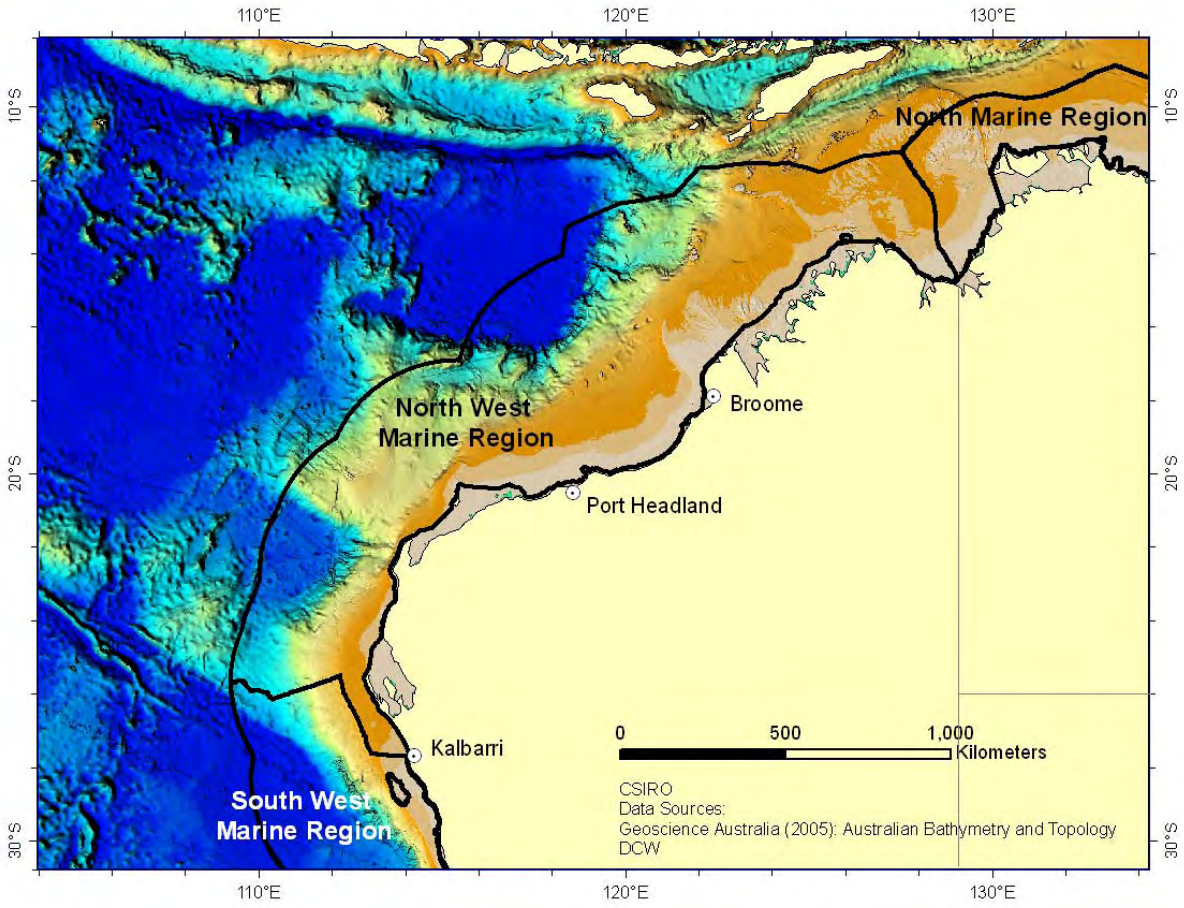

Figure 3-1 The North West Marine Region with the adjacent North and South West Marine Regions