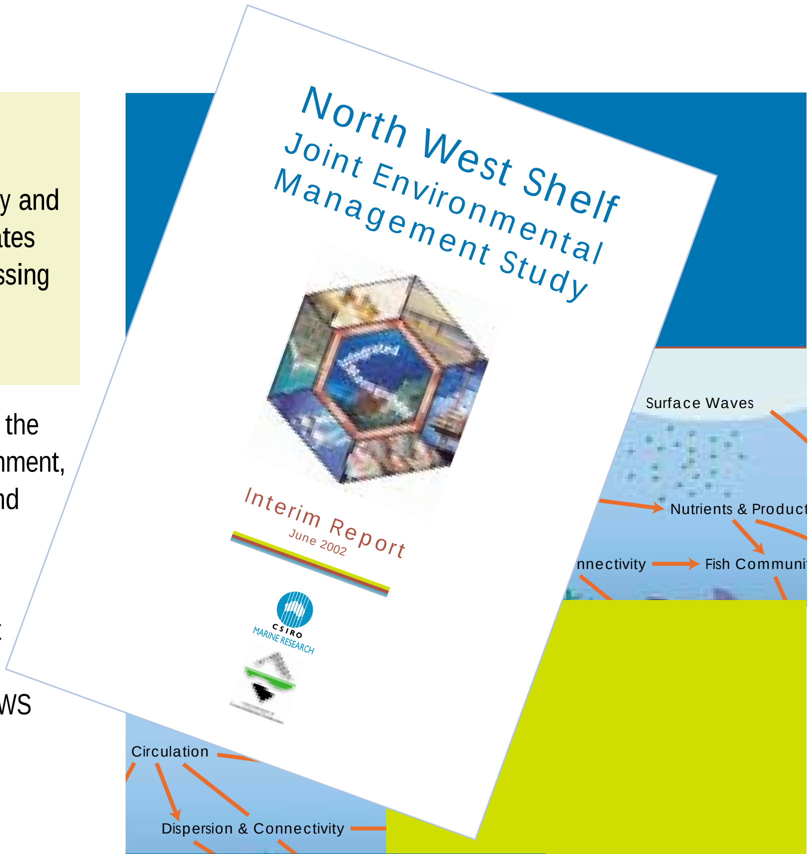
North West Shelf
Joint Environmental Management Study

off the shelf

Issue 3 October 2002

North West Shelf Joint Environmental Management Study Interim Report

The Interim Report of the North West Shelf Joint Environmental Management Study (NWSJEMS) has recently been published. The report outlines the Study and provides an update on progress to date. It demonstrates that all aspects of the Study are on track and progressing well. The Study commenced in July 2000 and will be completed in June 2003.



The NWSJEMS is a $6m marine environmental study of the NWS. It is jointly funded by the Western Australian Government, through the Department of Environmental Protection, and the CSIRO, through the Division of Marine Research.

The general objective of NWSJEMS is to develop and demonstrate practical and science-based methods that support, under existing statutory arrangements, integrated regional planning and management of the NWS marine ecosystems.

Summary of Progress

The Management Strategy Evaluation (MSE) framework has been used in the study to develop a computer-based system for evaluating existing and prospective multiple-use management strategies for the NWS. The MSE approach has been applied in many management situations elsewhere, but this is the first time an attempt has been made to develop and apply it to multiple use management of a whole regional ecosystem. The system developed through the study provides a model that links the ecosystem and human impacts, and predicts both the cumulative impacts of multiple-use of the NWS and the responses of the ecosystem to management measures. The model is presently a prototype, with many of the processes still represented by very simple models.

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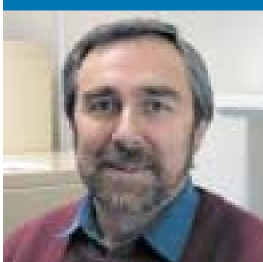
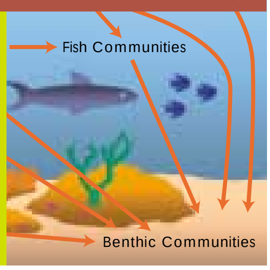
Dr. Chris Fandry
Co-Director, North West Shelf Study



Dr. Keith Sainsbury
Co-Director, North West Shelf Study



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The models and information required for comprehensive science-based support for multiple use management of regional ecosystems are challengingly complex, but NWSJEMS is demonstrating that they are achievable. While further development is required, especially in refining the MSE model, we have demonstrated that the approach is technically feasible. This is a first step towards achieving the ecologically sustainable development of the NWS region.

The key achievements of the study to date can be summarised under the two main study objectives.

Objective: To compile, extend and integrate the scientific information and understanding of the marine and coastal ecosystems of the NWS.

Achievements:

- Compilation and review of the previous scientific studies in the region;
- A data-base of information and observations from numerous previous studies and surveys, including from government sources, industry sources and the 'expert knowledge' of people very familiar with the NWS;
- User-friendly tools to access and view the data that has been assembled, including tools that are based on world wide web technologies;
- Compilation of an inventory of important pollutants and contaminants, including their sources, and quantities;
- A hierarchical classification and mapping of the main ecosystems and habitats that comprise the NWS regional ecosystem;
- Models of some of the key oceanographic and ecological processes, including water currents and dispersion pathways (e.g. pollutants or larvae), cycling of key nutrients, primary productivity, dynamics of seabed and coastal habitats, food webs, the dynamics of key species, and broad patterns of biodiversity; and
- Models of the impacts of some of the main human uses of the NWS regional ecosystem.

Objective: To develop and demonstrate practical, science-based methods that support integrated regional planning and multiple-use management for ecologically sustainable development of marine ecosystems.

Achievements:

- Identification with stakeholders of an initial set of industry development scenarios, objectives and performance measures for comparison of multiple-use management strategies;
- A functional although simplified model of the ecosystem, the ecological impacts of the main human uses, and the economic returns generated from those uses;
- A functional although highly simplified model of the management strategies currently being used to regulate some industry users of the ecosystem, and of the industry response to these management measures;
- Demonstration of the combined use of the ecosystem model, impacts model and management models in exploring the effect of a changed sectoral management strategy on that sector, other sectors and the ecosystem as a whole; and
- Demonstration of the approach at a stakeholder workshop.

Forward Plan

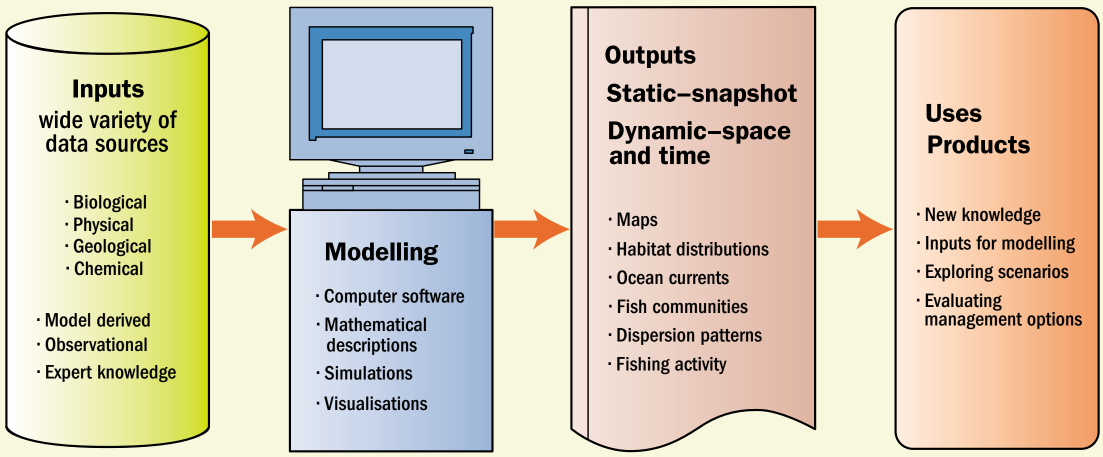
The work plan from this point on will refine the models and the data they are based on, and will further engage users in their application.

Some members of the North West Shelf Study team (from left): Vince Lyne, Scott Condie, Richard Little, David McDonald, Helen Webb, Clare Marty, Beth Fulton, Pamela Brodie, Brian Hatfield, Melanie Martin

Models probe the unkown

The proliferation of powerful desktop computers has had a dramatic affect upon today's science. At one time research was done, data was collected and hypotheses were formed by the evaluation of that data. Now things are done differently, many people would be surprised to see what goes on in a laboratory today. When data is brought in from the field it is placed in the hands of a modeller, who uses the data to create a representation of what was seen in the field. It's a kind of computerised reality.

An example of the modelling process



For example, the modelling of ocean waves. A physical model can be generated in a laboratory tank, or alternatively a computer model could be used. Using a computer also allows the modelling of objects and processes which could not be captured in a laboratory setting.

It is important to realise that model making is involved with the essentials of an object or process. All models are simpler versions of the real thing. Models allow us to "get a handle" on something more complex, and hopefully allow us to understand it better.

Modelling on a computer is rather similar except that the approach is more abstract and usually mathematical. Computer modelling entails making a description of the behaviour of some aspect of a real world. It is about building a blueprint or shaping the architecture of a system. More formally we can say it is "creating an analogue to a real object". Inevitably this means some kind of simplification of the real thing.

Modelling using computers is a process that is similar to that of building a physical model out of materials. The modellers decide what are the important features of their model, how these relate to each other and what tools or materials are available, and then construct the model, evaluate and validate it in some way and, if required, improve it.

What are the steps involved in making a computer model?

Decide what it is you are going to model. This will require some background understanding of the object or process that is to be modelled. Often it means simplifying what would otherwise be complex. Through some knowledge and observations of the real system identify the important features – the main components and how they interrelate, and the influencing factors or variables (input variables) that may affect the outcome or results.

Construct a mathematical model. Typically this will be a set of equations that describes the behaviour of a real world object or process. Convert the mathematical model into a computer model. This is not always a straightforward process and often requires the development of new software.

Use the model to get results. This process is called simulation. Computer simulation involves feeding values into the model to see how it behaves under specified conditions. Simulation is dynamic in that it exercises the static description of the model under a number of different conditions. These results can then be evaluated.

Models probe the unkown continued

Modelling is a useful and valuable exercise. Why?

It draws attention to how the whole the object or process works. The very act of making or understanding a model allows us to appreciate what is involved in the thing being modelled. It can show up deficiencies in the original formulation.

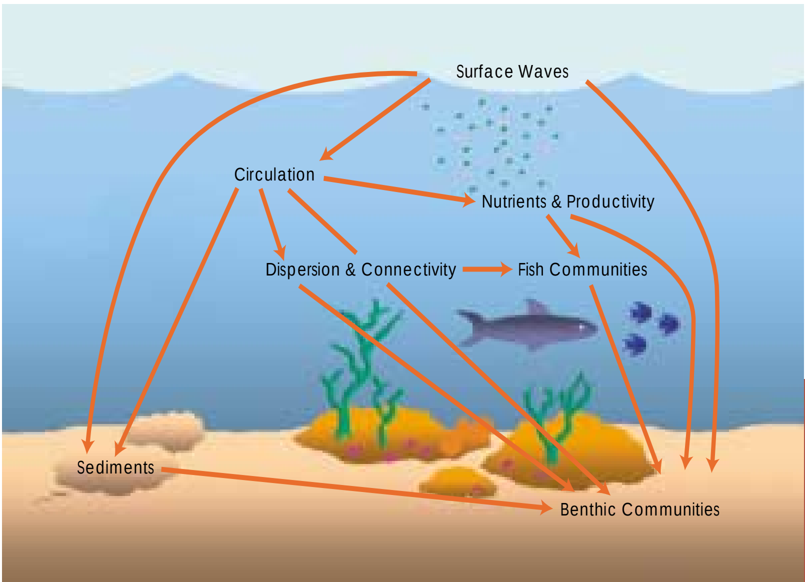
Because models are necessary simplifications, we cannot be sure that we have included all the important factors involved. Running a simulation through a model and comparing the results with what we might expect to happen can tell us whether our model fairly describes or represents what it is that we are modelling. As a result of our simulation we can go back and alter our model accordingly if it is needed, so it can produce useful results. If our model is reasonable then it will allow us to ask "what if" questions and it may provide us with predictions.

This is, essentially, what we want to be able to do with the models we are creating for the Northwest Shelf. In this issue of the newsletter we will be looking at some of these models and how they work with each other to answer some of the "what if" questions that need to be asked in order to better manage this valuable resource.

Modelling the North West Shelf ecosystems

Various models have been developed and used to represent different processes operating in the NWS ecosystem. Individually, these models provide an ability to examine and make predictions or interpolations about specific features on the NWS – including the wave environment, circulation and stress at the seabed, dispersion patterns, movement of sediments, nutrients and productivity, benthic and food web dynamics. This allows different processes, for example water circulation, or the passage of contaminants through the food web, to be examined individually, if that is required.

However, the models are also dynamically linked and can resolve both spatial and temporal dynamics. For example, the circulation models take outputs from wind and wave models, that in turn drive sediment and productivity models, and all of these provide inputs to the fish and benthic community models.



Modelling the Components

Waves

Wave action modifies forces on the sea-bed, on man-made structures, and on the shoreline. Waves generated by tropical cyclones in particular, may damage or destroy benthic habitat, initiate large scale resuspension and redistribution of sediment, and cause damage to coastal and offshore structures. Wave action also modifies the surface and bottom boundary layers, and can have a direct effect on circulation patterns.

Circulation

The North West Shelf is subject to a wide range of forcing, including large surface (and internal) tides, monsoonal weather patterns, and cyclones. A good understanding of the circulation patterns in the study area is fundamental to the ability to predict the transport and dispersal of water, sediments, nutrients, pollutants, and larvae.

Dispersion and interconnections

In the past a number of dispersion studies have been undertaken on the NWS to assess the contamination risk associated with both coastal and offshore industry developments. However, longer-term regional patterns of dispersion and connectivity have not previously been investigated. A more general framework has been developed in the NWSJEMS to support investigations of larval dispersion

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Schematic representation of major interactions operating in the NWS ecosystem. The arrows indicate flow of information between the models being developed for each of these components.

Modelling the North West Shelf ecosystems from previous page

and recruitment, and provide contaminant dispersal scenarios for risk assessment and management strategy evaluation.

Sediment transport

On the North West Shelf, sediments may be mobilised by a number of factors, including: large tidal motions in the shallow coastal areas; internal tides in areas around the shelf break; and cyclone induced currents and waves over the entire shelf region. These factors play a major role in determining water column turbidity (and hence light availability), and distributions of benthic habitats.

Benthic habitat dynamics

Benthic habitats are central to many ecological processes on the NWS and are a major factor in determining benthic biodiversity and production, as well as many pelagic processes such as larval recruitment and nutrient recycling. However, they are subject to natural disturbance, such as tropical cyclones, and to human impacts such as the effects of trawl gears on benthic habitats. Recovery rates of benthic habitat after disturbance by human activities or natural forces will largely determine benthic biodiversity and production, which in turn affect pelagic processes of the local ecosystems.

Nutrients and productivity

Nutrient loads and associated productivity levels are a major determinant of water quality, particularly in the coastal zone where anthropogenic inputs are most significant. While inputs of nutrients and other contaminants from human activities are currently relatively localised, the modelling capabilities being developed in the NWSJEMS will allow the impacts of increased loads from future developments to be evaluated in detail.

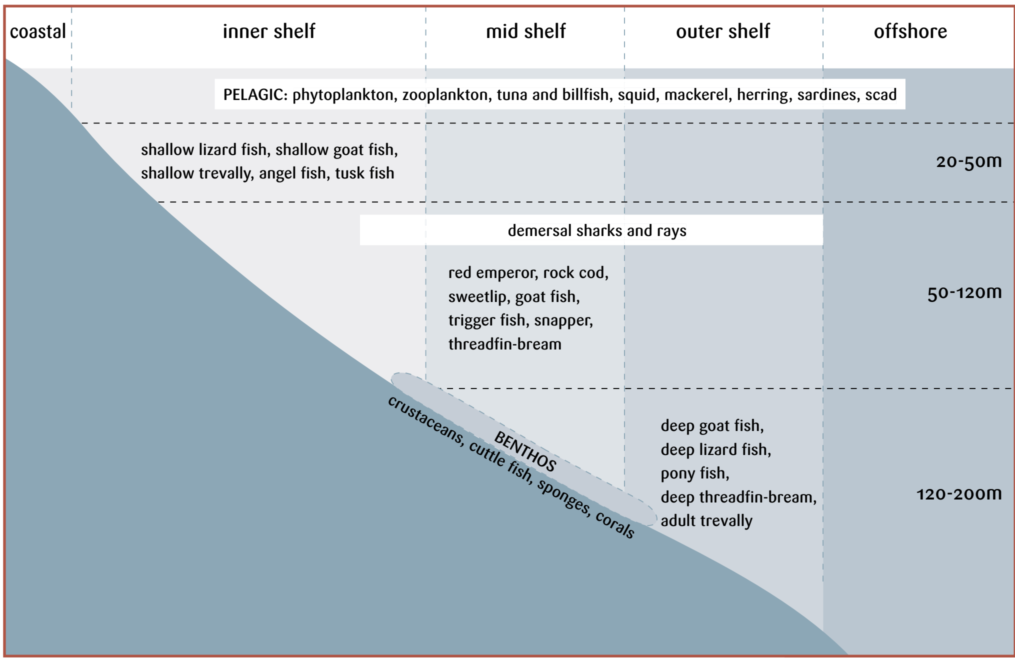
Food webs

Most species have a preferred horizontal range across the NWS (inner, middle and outer shelf) depending on environmental factors such as light, temperature, oxygen, and food supply; and a preferred depth range. A food-web model of these interconnected zones has been developed.

Like most tropical marine systems, the food web on the NWS is complex, with many connections and interdependencies. The model developed for the NWSJEMS illustrates the broad trophic connections between the zones (inner, middle and outer shelf) and between the major groups of organism. It combines information on primary production and the lower end of the food web, diets and feeding, surveys of the abundance of various types of organism (from sediment fauna to fish), fishery catches, and the shared species across the zones. The model can be used to broadly examine such things as the major trophic interdependencies, passage of contaminants through the food-web, changes in the food-web resulting from harvesting or otherwise reducing various parts of the food-web, and the broad amount of fishery yield that is possible from different parts of the food-web.

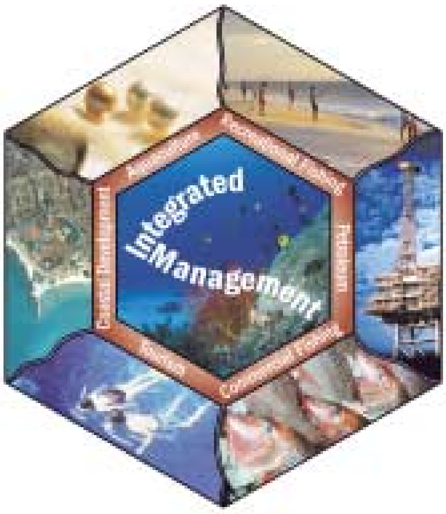
Interlinked Models

The development of these interlinked models of the North West Shelf ecosystem will provide an understanding of the links between the physical, chemical and biological environments. In many cases these models are prototypes that are still under development, but already they provide a comprehensive suite of tools for the prediction and interpretation of natural and human impacts on the NWS.



A food-web model of interconnected zones

Managing for today and tomorrow



The North West is ecologically complex and diverse. The seabed habitats of the North West Shelf support the highest biodiversity recorded anywhere in the world. They support a remarkable array of marine fauna, including tropical fish, turtles, hard and soft corals, sponges, and a great many crustaceans. The marine biodiversity is extensive and includes major coral reef systems, coastal mangrove areas, and a host of other distinctive marine species, including charismatic large fauna such as whale sharks, turtles, and dugongs.

Western Australia's North West Shelf is a $6 billion contributor to the national economy and the most economically significant land or sea region in Australia. It produces the majority of Australia's domestic and exported oil and gas. Other major industries operating on the shelf include commercial fisheries, aquaculture (especially pearl farming), salt production, iron ore processing, shipping (associated with the transport of oil, gas, salt and iron ore) and a rapidly expanding tourism industry.

With the rapid growth of marine industries across a range of sectors, the potential for conflict between different uses of the marine environment is increasing. From experience elsewhere in the world environmental quality and the ecological sustainability of industries, with their associated employment and wealth generation, may be compromised at some point unless development occurs in an integrated and ecologically based management framework.

The North West Shelf Joint Environmental Management Study will significantly increase our basic understanding of the marine ecosystem, produce a range of predictive tools, including ones to support management decision-making, as well as provide some information on potential impacts of the major activities. The study will also provide the scientific foundation for an integrated, ecosystem-based approach to environmental management and planning.

Study Collaborators

WA Department of Environmental Protection
and CSIRO Marine Research

Project Support

West Australian Government
Minerals and Energy, Fisheries, Conservation and Land Management

Science

Australian Institue of Marine Science,
Australian Geological Survey Organisation

Additional Information

Dr Chris Fandry, WA Dept. of Environmental Protection
Phone (08) 9222 7019

Dr Keith Sainsbury, CSIRO Marine Research
Phone (03) 6232 5456

http://epagate.environ.wa.gov.au
http://www.marine.csiro.au/nwsjems/index.html

Photography from: Centre Coral Reef Ecosystem Clay Bryce - WA Museum; Aquaculture Pearls and Commercial Fishing fish - WA Fisheries; Recreational Fishing Jirri Lockman - WA Fisheries; Petroleum Woodside Platform - Woodside Energy Ltd (Cotton, I.); Tourism CSIRO; Coastal Development Aerial shot - Hammersley Iron Pty Ltd.

CSIRO
MARINE RESEARCH

CSIRO Marine Research
GPO Box 1538, Hobart Tas 7001
Castray Esplanade, Hobart, Tasmania 7000
Phone (03) 6232 5222 Fax (03) 6232 5000

Department of Environmental Protection

Western Australia Department of Environmental Protection
PO Box K822, Perth WA 6842, Westeralia Square
141 St Georges Terrace, Perth, Western Australia 6000
Phone (08) 9222 7000 Fax (08) 9322 1598