

WAMSI Biannual Progress Report to 30 November 2008

WAMSI Node 1 Project 2 (WAMSI Code 1.2): Coastal ecosystem characterisation, benthic ecology, connectivity and client delivery modules

WAMSI Project Reference No: 1.2

Project title: Coastal ecosystem characterisation, benthic ecology, connectivity and client delivery modules

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2.1 An assessment of the importance of physical forcing and ecological interactions among key functional groups in determining patterns of spatial mosaics in benthic habitats. Ongoing analysis of survey data has confirmed the existence of statistically significant across-shelf trends in the dimensions and overall proportion the spatial mosaic structure on reefs in Marmion lagoon. Gaps in algal canopy habitats are larger and more frequent on the outer edge of the reefs than they are elsewhere.

A wave hydrodynamic model of the Marmion region has now been developed and implemented to obtain estimates of annual wave climate and variability for the study region, including sites used for habitat patch transects. Outputs from the model including both mean and maximum wave induced water velocity at the sea bed have been compared with reef habitat patch structure in order to test the hypothesis that waves are a potential causal mechanism in the formation or maintenance of patches. Both mean and maximum water velocity were positively correlated with gap size, explaining approximately 25% of total variation

Other factors that may be involved in gap formation have also been examined, including feeding by grazing fish and invertebrates. The abundance of these groups was not correlated with gaps, suggesting that feeding by these groups unlikely to be a major cause of gap formation.

Experimentally created gaps, continue to be monitored in order to better parameterise models of gap formation and infilling. In parallel with this, we are now conducting measurements of coral growth and age in order to corroborate models of gap dynamics.

Since climate change will affect both wave and temperature regimes off the WA coast, understanding of gap formation processes is essential to predicting how this key primary producer will react, and assessing the resilience of WA coastal ecosystems.

2.2. An assessment of ecosystem processes with particular relevance to contrasting fished and non-fished areas Timely decision-making for ecologically sustainable management requires the ability to rapidly and cost-effectively address the condition of resources and the ecosystems that sustain them. Research in this component of WAMSI Node 1 Project 2 has been directed at assessing the patterns of abundances of key groups of species that are important commercially or ecologically, and at key ecosystem processes that influence, and are influenced by, these patterns. Because one likely important modifying process on the temperate west coast of Australia is fishing by humans, surveys have been structured in a way that uses management units that aim to provide spatial refuges from fishing (sanctuary zones in DEC and RIA managed marine parks).

Surveys of abundance have encompassed finfish, rock lobsters, and large invertebrates, and have been done at 26 sites. Where possible, surveys encompassed reef, and seagrass and bare sand habitats. In addition, surveys of rates of herbivory and rates of predation have been performed. Sites have included six sanctuaries, two each at Rottnest Island, Marmion Lagoon, and Jurien Bay – these sanctuaries include a range of sizes from ~1 ha to >1,300 ha, and a range of ages from 3 years to 20 years.

Preliminary analyses suggest that key targeted taxa (rock lobsters and finfish) are generally more abundant inside sanctuaries than in the same area of equivalent habitat in areas open to fishing. This was especially evident for rock lobsters (5 of 6 sanctuaries). Abundance of rock lobsters and targeted finfish was not simply related to the size and age of a sanctuary, but size and age together explain a statistically significant proportion of the variation in abundance. The greatest responses were in sanctuaries that were old (20 years) or large (>1,300 ha). The weakest responses were observed in small sanctuaries.

The spatial patterns in abundance of targeted taxa were not reflected by the rates of predation on mussels. There was little difference in the rates of survival between sanctuary and fished areas. However, there was a very strong difference between caged and uncaged mussels - uncaged mussels showed very low survival (30%) while caged mussels showed high survival (93%). This result suggests that predation (at least on organisms such as mussels) is likely to be a ubiquitously important process, and is high even where abundances of some predators have been depleted.

Further quality control of data, entry of data into databases, and additional surveys to fill small gaps in the data, are likely to be the focus of next efforts.

2.3. An assessment of likely dispersal patterns for marine organisms based on hydrodynamic and population genetic models. Sea urchins were sampled between Geraldton and Esperance for assessment of population structure using DNA sequence variation. This phylogeographic analysis will be coupled with hydrodynamic dispersal modelling to determine biological connectivity under the influence of the Leeuwin Current system.

We have now developed protocols for reliable DNA sequencing of the Cytochrome Oxidase I mitochondrial gene and four nuclear exon-primed intron crossing (EPIC) regions to assay phylogeographic structure in West Australian urchins. Potentially suitable DNA sequence variability exists across the full sampling range in two species *H. erythrogamma* and *P. irregularis* and these form the basis of the comparative study based on samples at four widely spaced sights (Jurien, Marmion, Albany and Esperance). Sequencing should be completed early in 2009.

To model the influence of hydrodynamic processes on urchin larval dispersal, a deterministic particle tracking model has now been implemented in Matlab for the BLUELink Re-analysis (BRAN) model outputs during 2003, 2004 and 2005. Particle tracking experiments have been carried out to quantify the fate of the Leeuwin Current waters.

Preliminary results show that a significant portion of the Leeuwin Current particles, representing more than one third of the Leeuwin Current southward volume transport, are advected around Cape Leeuwin and eastward into the Great Australian Bight. The rest of the particles are dispersed by the Leeuwin Current eddies and interaction with the continental shelf. Analysis is underway to better quantify these processes and to extend the modelling domain to Esperance.

2.4. Electronic delivery of data and models to management agencies, building on the development of the Data Interrogation and Visualisation Environment (DIVE) in SRFME.

New features in DIVE since the June 2008 milestone report are as follows:

- The user can now select the time-zone in which the data are displayed.
- Data can be viewed in “single steps” through the time series or vertical layers.
- There have been many interface and consistency improvements:
 - A “busy indicator” shows users when DIVE is active but busy.
 - Improved display of data for multiple datasets and multiple variables, through the use of colour and line styles.
 - Hiding and display of data depending on the selected viewing time. .
 - Improved animation exporting:
 - more options on time-range to export.
 - export of AVI format as well as animated gif.
- Files in GeoTIFF format (e.g. navigation charts) can be used as backdrops.
- The user-preference system has been improved.
- The “lift-out” function has been improved .
- DIVE now has the ability to read multiple files in folder-based datasets as a single source.

.Modifications in progress include:

- Ability to read ROMS (Regional Ocean Modeling System) output.
- Ongoing restructuring and improvement to facilitate improved display of biological and underway datasets.
- User-facility to create and edit symbols, and to add text to annotate DIVE output.
- The DIVE manual is being updated – this should be completed by the end of calendar year.

Scoping is currently underway for a "wizard tool" that will enable biological scientists to create relational database records from arbitrarily formatted data in documents such as Excel spreadsheets. DIVE will be able to display data from the relational database records so created.

DIVE is also being extended to use OGC (Open Geospatial Consortium) Catalogue Services standards to access data sets across the web. This capability will enable DIVE to access data sets archived by the Australian Oceanographic Data Network (AODN), and the Australian Integrated Marine Observation System (IMOS), which have both adopted OGC standards.