National mapping of deepwater biotopes based on multi-beam acoustics

• Rudy J. Kloser[1] • Gordon Keith[1] • Mathew Sherlock[1]

A program to map the deepwater biotopes of the Australian EEZ is underway based on fine scale acoustic multi-beam echo sounder (MBES) mapping and a newly developed benthic, optical, acoustic grab sampler (BOAGS). Data are collected on specific research voyages as well as utilising transit voyages between ports. These MBES data and associated physical and optical sensing are an important input into assessing key ecological features (e.g. canyons, terraces, banks, seamounts and deep reefs) for regional marine planning, informing the placement of marine protected areas and fisheries spatial management. The acoustic data provide detailed (20 to 50 m grid) bathymetric and inferred substrate information that can be used with other co-variates to predict macro faunal functional groups based on physical and optical "ground truthing". A consistent approach of interpreting ecological hard and soft substrate based on the acoustic backscatter that maximises the spatial resolution whilst minimises sources of error was developed and applied. This consistent nationally applied acoustic backscatter processing method is highly correlated with visual and physical sampling of the seabed as well as mega fauna diversity. Mega fauna diversity of 6 taxon grouping ~2000 species is highly correlated to both the seabed hardness and the depth of sampling. Nested within a hierarchical classification scheme estimates of seabed hardness are derived for catchments, specific geological features (canyons, seamounts) and MPA's. Based on this work we propose that seabed hardness as derived from multi-beam acoustics should be included in regional marine planning processes at a number of scales from regional mapping at the 100's km scale to the 10's m to 1 km scale for final MPA placement and fisheries spatial management.

Introduction

Australia's continental margin defined here from ~150 m to 1500 m, is a narrow strip characterised by high productivity and diversity (Fig. 1). While supporting a major ecological and economic (fishing, oil and gas) resource, this area is poorly-understood yet heavily exploited in parts.

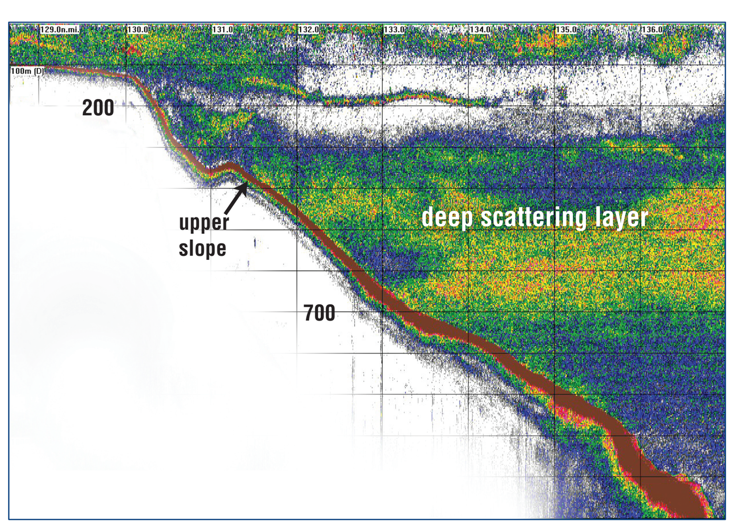
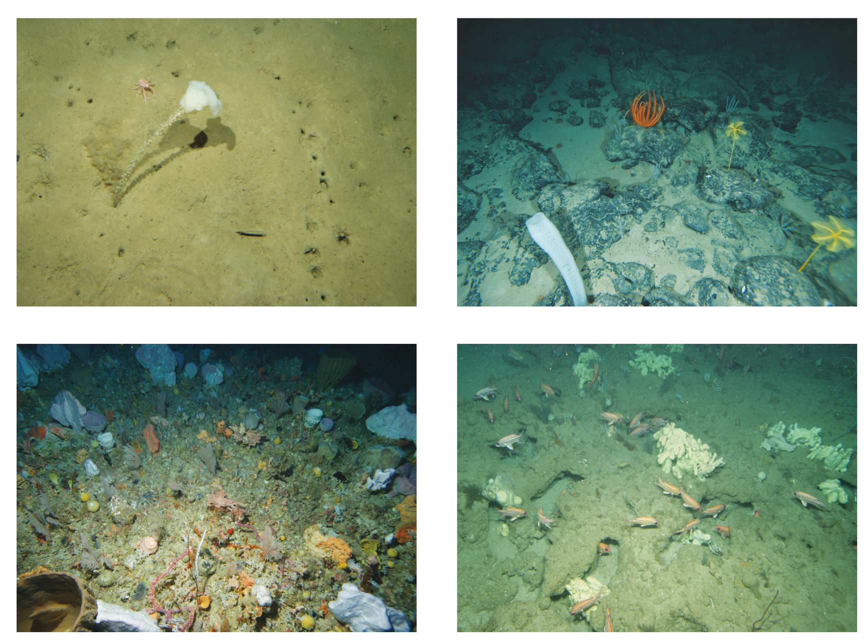


Figure 1: The continental margin upper slope as shown on this 38 kHz echogram is an area of considerable biological activity which intersects with the deep scattering layer, a food source for many of the larger fish.

A simple first step to assist management of this region is to map the spatial scales of the types of terrain and key components of the biotic assemblages to define marine habitat patches and key ecological features (e.g. canyons, seamounts and deep reefs). Mapping with multi-beam acoustic and optical methods is attractive due to their collective properties: large sampling coverage per unit cost, non-destructive sampling and high spatial resolution.



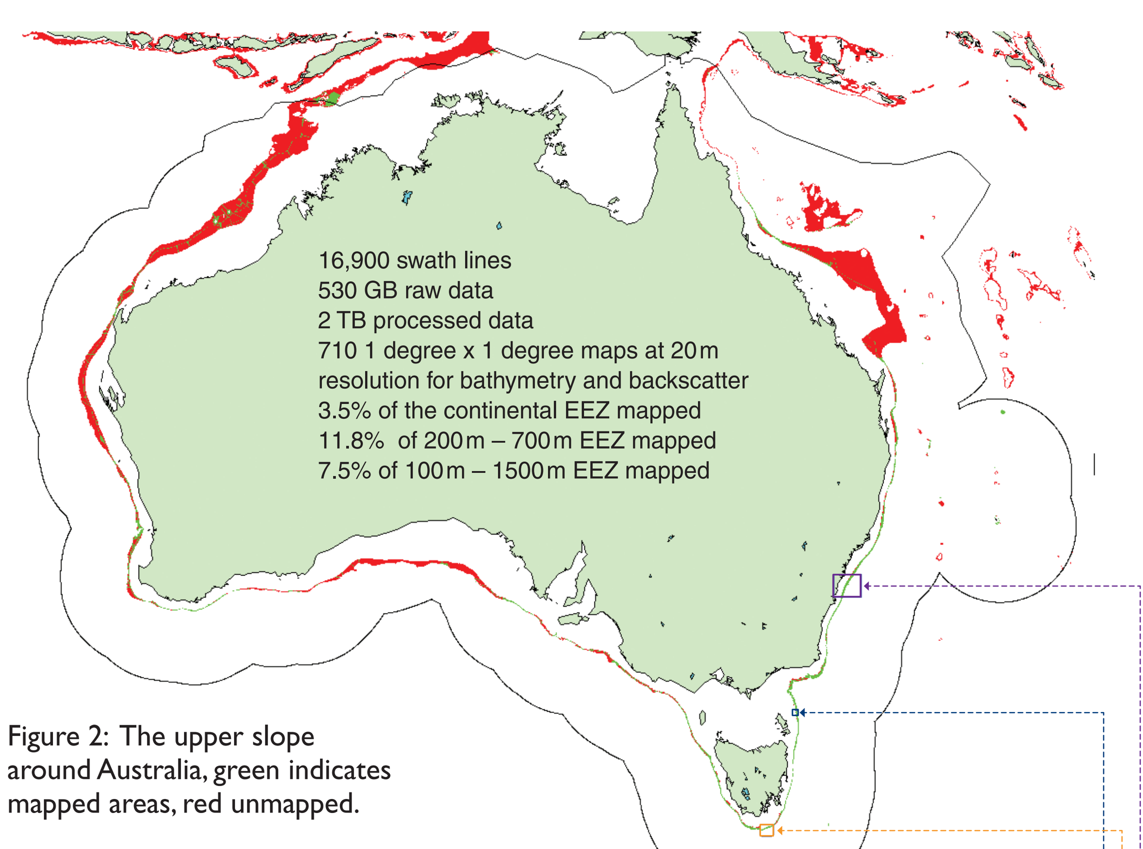


Figure 2: The upper slope around Australia, green indicates mapped areas, red unmapped.

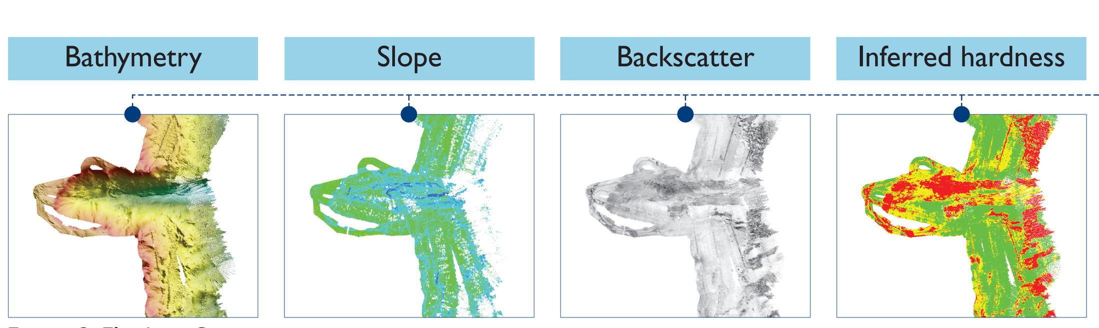


Figure 3: Flinders Canyon.

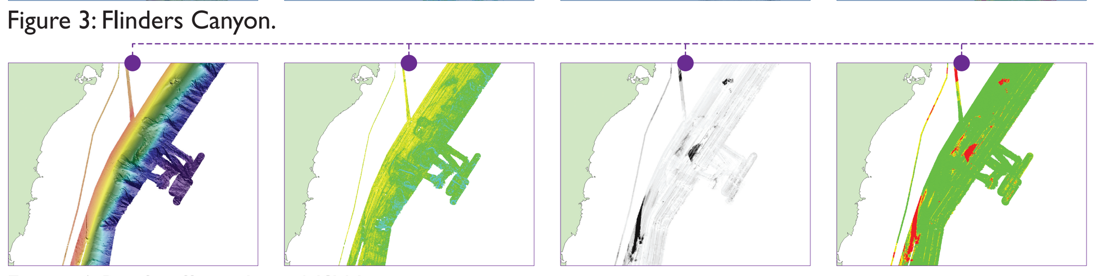


Figure 4: Reefs off southern NSW.

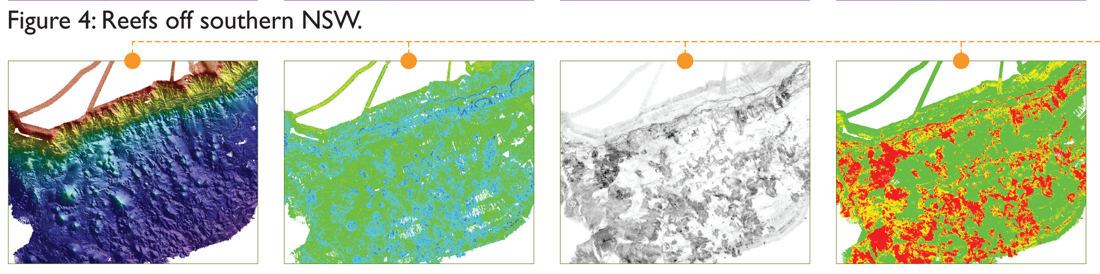


Figure 5: Tasmanian seamounts.

Multibeam Data

The MBES data has been compiled and processed in a consistent way to provide a dataset of bathymetry and backscatter over the Australian EEZ at approximately 20 m resolution. We use MB-System software with a suite of modified processing scripts to provide a system which allows easy integration of new data into the dataset. Backscatter data is corrected for absorption, depth anomalies and seabed slope before referencing to a common 40° incident angle.

Bathymetry and backscatter are gridded at 20 m resolution in 1° × 1° grids for numerical analysis and in 512 pixel by 512 pixel grids from 1/8 degree to 64 degree size for the generation of TIFF images. The resulting geoTIFFs, at multiple resolutions, are fed into a GeoServer Web Mapping Service (WMS) to provide a simple interface to an otherwise large and unwieldy dataset.

This dataset provides maps of bathymetry, slope and seabed hardness (inferred from backscatter) from which we build an inventory of important features, including shelf incising canyons, deepwater reefs and seamounts (Figure 3 to 5).

Benthic, Optical, Acoustic, Grab Sampler (BOAGS)

Seabed features identified with the MBES data are sampled with a benthic, optical, acoustic grab sampler (BOAGS). The system combines live video data via fibre optic cable, single beam echosounders and a sediment grab system to allow accurate identification of sediment samples and co-located fauna. The BOAGS allows the operator to optically sense hard rugged and soft terrain, obtain sediment grabs from soft terrain and to visually determine whether the grab has successfully fired.

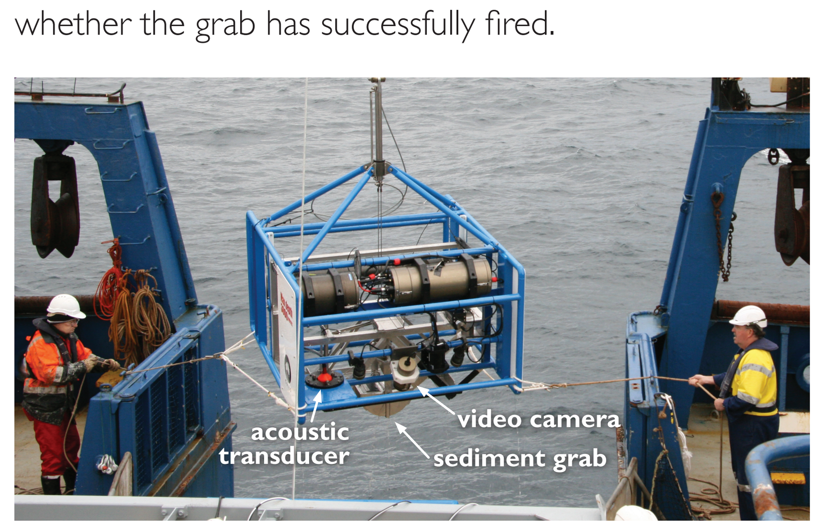


Figure 6: Benthic, Optical, Acoustic, Grab Sampler.

Hard/soft seabed

A simple classification of seabed into hard, soft or intermediate based on MBES backscatter data provides a basis for predicting faunal communities. Video analysis of benthic fauna has shown strong association between some faunal types and hard or soft ground (Figure 7). Physical sampling has also recorded high correlations between hard and soft ground and biodiversity metrics of number of species and number of individuals (Figure 8).

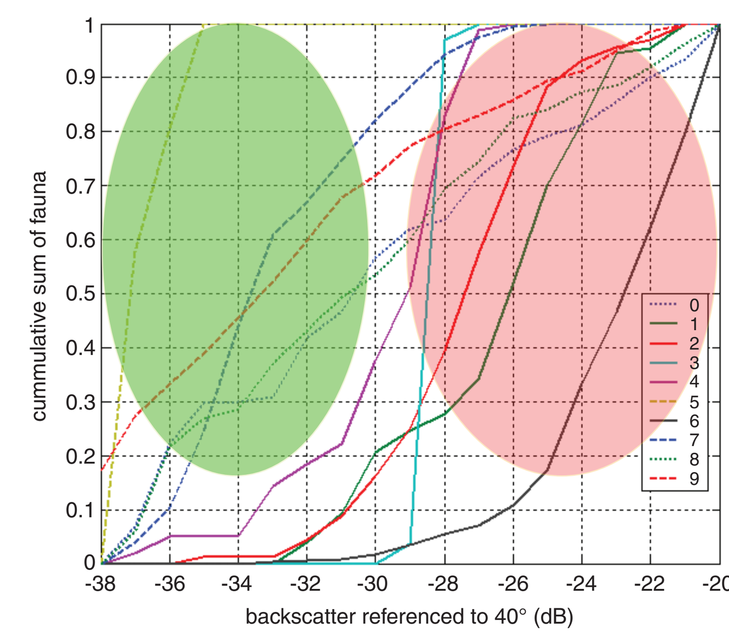


Figure 7: Video classified fauna types 0 to 9 (35000 scores) associated with increasing values of backscatter where soft type fauna are associated with lower backscatter (dashed) and hard associated fauna associated with high backscatter (solid) and no affinity dotted.

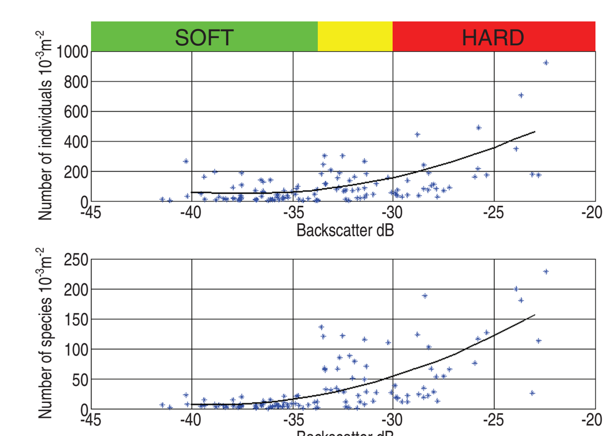


Figure 8: Based on benthic sled and beam trawl sampling mega fauna diversity of 6 taxon grouping ~2000 species is highly correlated to both the seabed hardness and the depth of sampling.

Conclusion

Based on this work we propose that seabed hardness as derived from multi-beam acoustics should be included in regional marine planning processes at a number of scales from regional mapping at the 100's km scale to the 10's m to 1 km scale for final MPA placement and fisheries spatial management. A national scale dataset of both bathymetry and backscatter will assist in the management and classification of seabed features especially in the important upper slope and adjacent areas.

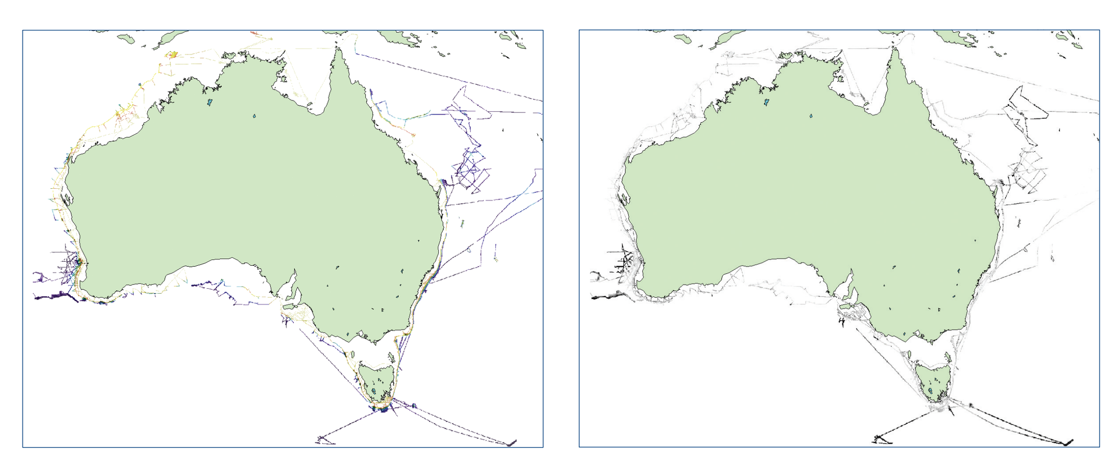
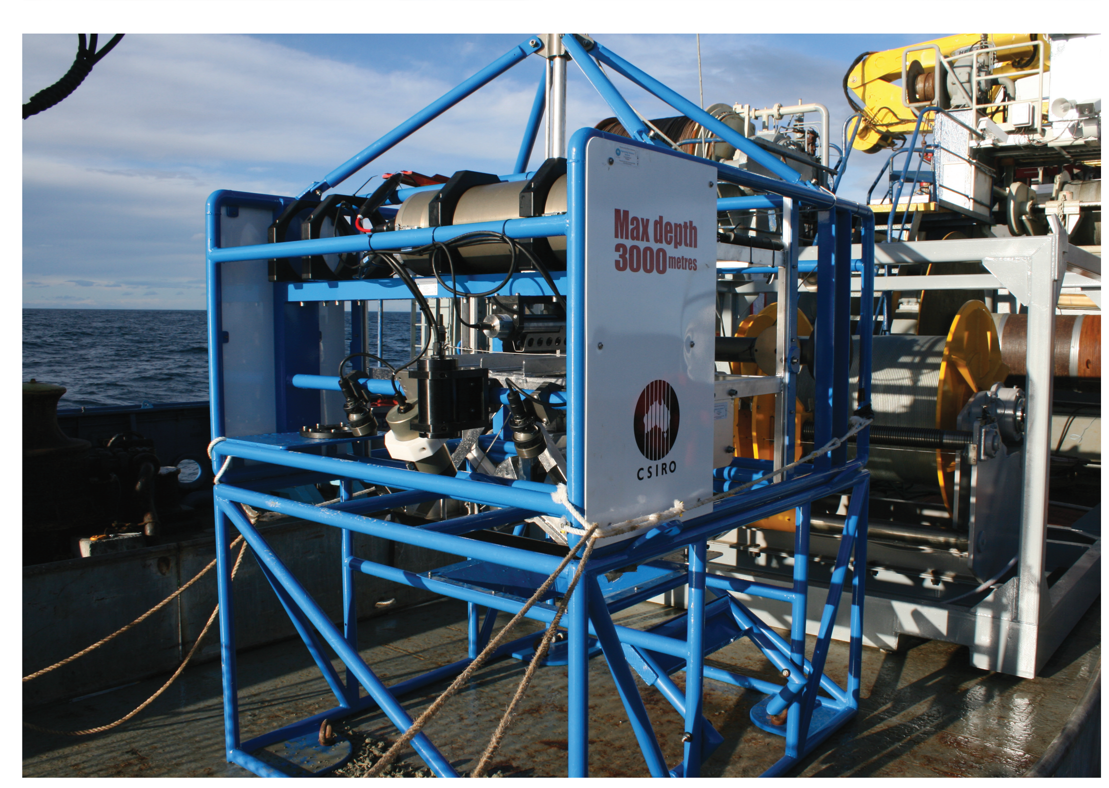


Figure 9. National bathymetry and backscatter maps.



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[1] Wealth from Ocean Flagship, CSIRO Marine and Atmospheric Research, GPO Box 1538 Hobart 7001, Tasmania, Australia

Further information
Gordon.Keith@csiro.au

www.csiro.au

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