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Statistical analysis of video transects for areal prediction from expansive data

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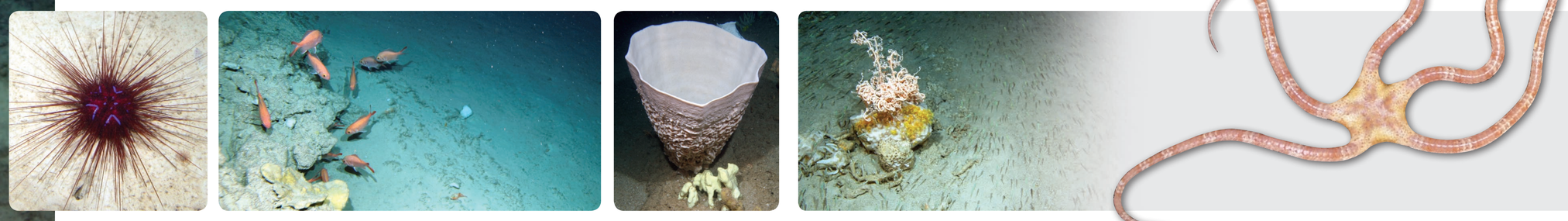

background

Underwater video data collection is becoming more widespread with recent improvements in technology and affordability. However, no appropriate analytical methods to take advantage of these data have hitherto been developed. Observations taken along a camera transect are strongly auto-correlated and require special statistical methods.

Figure 1: Voyage of Discovery survey area.

video data

A series of 62 video transects was taken during a large scale survey in 2007 (the Voyage of Discovery; Figures 1 & 2 for locations).

The video was scored for fauna-type (F), geomorphology and substrate, with the last two variables combined into a single descriptor of the local environment, termed the environment-type (E). We modelled the proportions of F and E along each transect using expansive physical covariates. The modelled distributions can be used to interpret ecological patterns and to predict into unsampled locations.

models

The data from each frame is multivariate and there are strong auto-correlation within each transect. To account for these artifacts we decompose the joint distribution of the fauna-type and the environment-type as

$$\Pr(F,E) = \Pr(F|E)\,\Pr(E)$$

and model each component as a single Markov chain model. This model has a simple formulation and its parameters are specified to be functions of the physical covariates.

predictions

We chose to illustrate prediction methods with data from the Perth Canyon. The predictions for fauna-type and environment-type were made marginal to each other on a 0.01° grid and the point predictions are given in Figure 3 for two environment-types and Figure 4 for two fauna-types. There are complex patterns driving the spatial distribution of these categories.

An areal prediction for the proportions of fauna-type for the spatial area specified defined by Figure 3 was also performed, see Table 1. These predictions will be important for spatial management as these are the likely proportions of each fauna-type that would be preserved by a putative Marine Protected Area (for example). The associated prediction standard errors are important as these give an indication of how reliable the predictions are. Two of the standard errors are huge and possibly indicate a problem with the model.

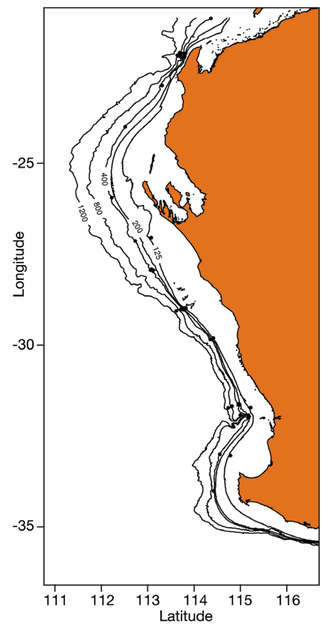

Figure 2: Enlarged survey area with depths and sample points.

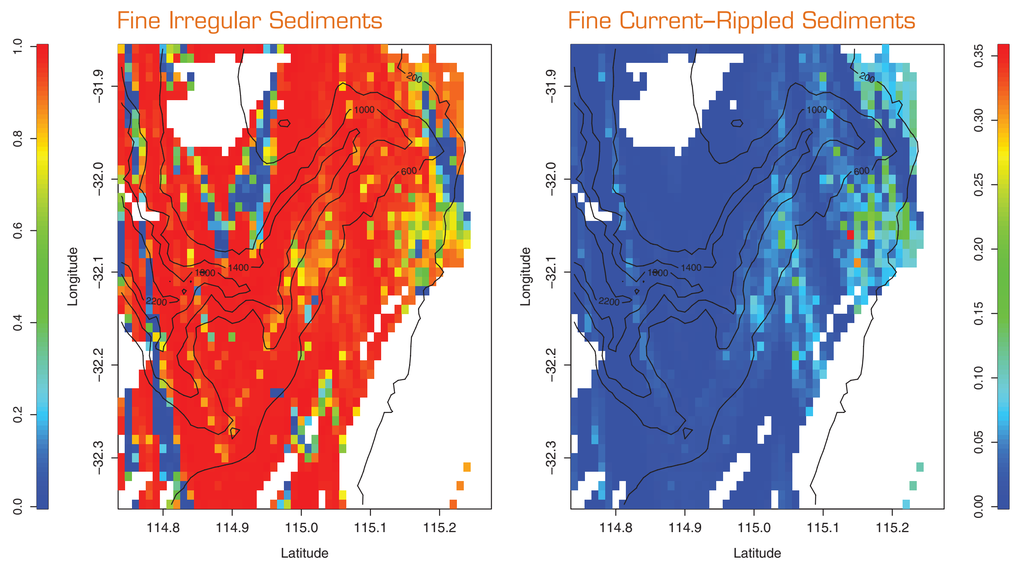

Figure 3: Predicted proportions for environment-types *fine irregular sediments* and *fine current-rippled sediments*.

Fauna	Prediction Proportion	Prediction Standard Error
Bioturbators	0.381	0.047
Anemones	0.044	0.009
Fan Sponges	0.021	0.016
Lumpy Sponges	0.072	0.027
Branched Sponges	0.017	0.009
Quilled Soft Corals	0.128	1.578
Branched Soft Corals	0.008	0.015
Unbranched Soft Corals	0.010	1.659
Crinoids	0.305	0.050
No Visible Fauna	0.013	0.067

Table 1: Area predictions for fauna-types in the Perth Canyon area.

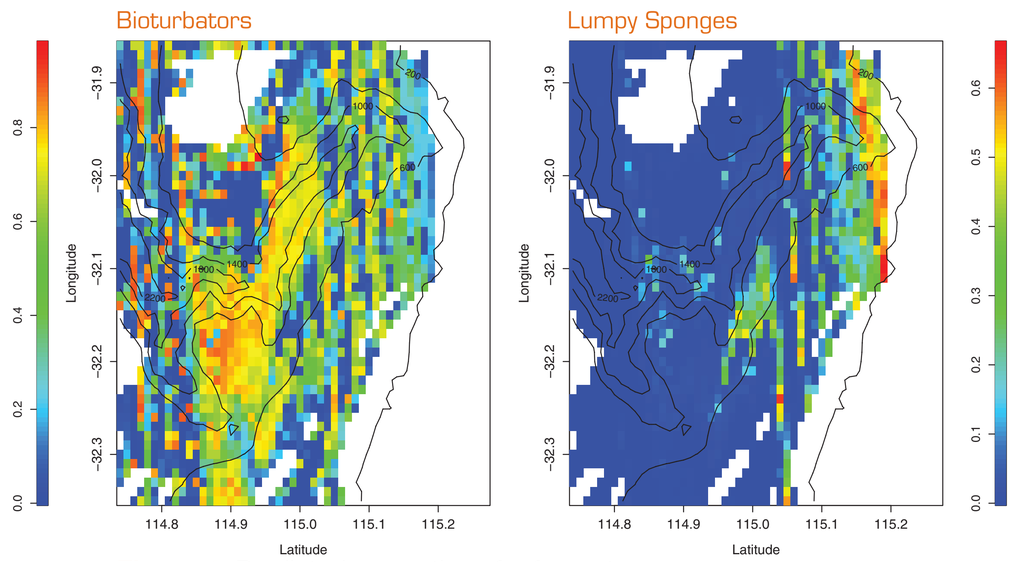

Figure 4: Predicted proportions for fauna-types *bioturbators* and *branched sponges*.

conclusions

We demonstrate that video data in conjunction with expansive physical data can be used to provide predictions of the functional groups observed in the video. These predictions are useful for spatial visualisation and for area prediction to inform management decisions.

references:

- Foster, S.D., Bravington, M.V., Williams, A., Althaus, F., Laslett, G.M., and Kloser, R.J. 2009. Analysis and prediction of faunal distributions from video and multi-beam sonar data using Markov models. Environmetrics *in press*.
- Foster, S.D. and Bravington, M.V. Graphical Diagnostics for Markov Models for Categorical Data *in review*.

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