Bayesian Statistical Issues in Coral Reef Ecology

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In this talk I will describe a number of statistical issues arising from a continuing collaboration between statisticians at (or formerly at) the University of Sheffield and coral reef ecologists from the Marine Spatial Ecology Lab (MSEL) at the University of Exeter.

The MSEL works on a wide range of projects in coral reef ecology and remote sensing, including the dynamics of the coral-based ecosystem, the design and evaluation of marine nature reserves, and the spatial modelling and prediction of coral populations and marine biodiversity. The types of data collected by MSEL, or available to them, vary enormously, from detailed—and expensive—data at the centimetre scale, collected by researchers using scuba gear and video cameras, to satellite images with a resolution of the order of 10m.

One important recent project concerns the prediction of the presence/absence of *Montastraea annularis* coral from a combination of local covariates, such as depth of water and exposure to waves, and a regional influence which is hard to model explicitly but can be thought of statistically as a random effect. Taking into account spatial dependence in the presence/absence itself, we have shown that a fully Bayesian approach allows us to reconstruct regional random effects, and hence predict coral presence accurately, for regions that have known covariates but *no* information on the coral itself. This allows meaningful predictions of coral location, complete with an assessment of uncertainty, to be made using covariate information that is relatively easy to map.

The newest strand of this joint research concerns the use Bayesian methods to combine sources of information on coral mapping: local ‘ground truth’ data, obtained by diving; population ecology models, incorporating detailed expert knowledge; remote sensing data, collected by air and by satellite; and numerical models of the passage of light through aquatic systems, based on 3-dimensional mechanistic modelling of light propagation and of the physical structure of coral. This work exploits the strength and coherence of the Bayesian approach to make full use of the wide range of data available to learn about the dynamics of the coral ecosystem. It is important both from a theoretical perspective, for increasing our understanding of coral dynamics, and for conservation purposes.