BAYESIAN GRAPHICAL MODELS. APPLICATIONS TO QUANTITATIVE MODELLING, INFERENCE AND PREDICTION IN AQUATIC AND FISHERIES ECOLOGY

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Bayesian graphical models (BGM) coupled with sequential Monte Carlo methods, provide a flexible framework for quantitative ecological modelling. They can handle the high dimensional models with multiple sources of variability and uncertainty, which are typically needed for ecological inference and prediction. The conditional reasoning statement provides a support for structural modelling of complex relationships linking parameters, latent states variables and observations. The setting encompasses a wide range of models including hierarchical (multilevel) and dynamic state-space models. Diagnostics and predictions are derived on a probability based rationale and are easily embedded in a formal decision analysis.

The value of BGMs is illustrated using three examples issued from aquatic and fisheries ecology. The first one is a hierarchical model for estimating a salmon population size via the successive removal method. The benefits of hierarchical models to analyse large but sparse data sets are highlighted. The second is a one-dimensional state-space model for the biomass production model applied to a tuna fishery. It is shown how probabilistic assessment of reference points for the management of the fishery, as well as risk assessment, can be derived. The third example is a multi-dimensional state-space model for a stage-structured salmon population model. The system dynamics includes non linear regulation and has a probabilistic structure. The observation model mainly arises from capture-mark-recapture experiments. Inferences on the model parameters and predictions for the population are presented.