State space modelling of temporal dependence in fisheries data using copulas

Geoffrey R. Hosack[a] and **Gareth W. Peters**[b] and **Stuart A. Ludsin**[c]

[a]Division of Computational Informatics
Commonwealth Scientific and Industrial Research Organisation
Hobart, Tasmania, Australia
geoff.hosack@csiro.au

[b]Department of Statistical Science
University College London
London, UK
gareth.peters@ucl.ac.uk

[c]Aquatic Ecology Laboratory
Department of Evolution, Ecology, and Organismal Biology
The Ohio State University
Columbus, Ohio, USA
ludsin.1@osu.edu

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Abstract: Fisheries management decisions are often informed by models based on catch per unit effort (CPUE) data, for example, the number of fish caught per hour of fishing. Uncertainty arises from three sources: (1) observation error in the aggregated catch or effort data, (2) the interaction between a fishery and the fish population ("catchability"), and (3) the unobserved population's dynamics. Here, a state space model is used within the context of unknown observation error and catchability to explore whether or not the dynamics of two managed populations display stochastic dependence features. This dependence is modelled with Archimedean copulas previously applied in the domains of hydrology, financial and insurance risk. A positive association between the two populations is suggested, where the choice of copula affects the probability that the populations exceed a management threshold. An alternative hypothesis instead considers a common factor that introduces temporal dependence among the CPUE data independent of the populations' dynamics; this second pathway of dependence is imposed through the catchabilities of the multiple fisheries. Although this hypothesis also receives some support from the data, the inclusion of the common factor has a negligible impact on the probability of the populations exceeding the management threshold, compared to the choice of copula.

References

Hosack, G. R., Peters, G. W. and Ludsin, S. A. (2014) Interspecific relationships and environmentally driven catchabilities estimated from fisheries data. *Canadian Journal of Fisheries and Aquatic Sciences*, Accepted.