Multispecies modelling with correlated Gaussian processes priors

Marcelo Hartmann* Geoffrey R. Hosack †
Richard M. Hillary† Jarno Vanhatalo*
hartmarc@helsinki.fi

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Density dependent population growth models (stock-recruitment models) are of central importance in population dynamics modeling. Traditional approach for modeling them assumes fixed functional form, such as Ricker or Beverton-Holt, with temporally constant parameters and without species interactions. In recent years, there has been increasing interest towards semi-parametric and temporally varying population growth models. In the former, deviations in stock-recruitment relationship around the expected parametric form are described by semi-parametric model such as Gaussian processes and in the latter, e.g., the maximum reproductive rate is assumed to vary in time. In this work, we present the Ricker model and its extensions to a time varying model, species interactions, semiparametric corrections and the combination of all these under the same Gaussian process framework. Once our model is nonparametric it carries less restrictive assumptions about the functional evolution of the maximum reproductive rate over time, being also able to capture the dependence between species over time. In our case study, we analyze the reproductivity of three species of salmon, sockey, chum and pink from Weaver Creek spawning channel in Canada through years 1965-2015. Our results show clear temporal variation in the maximum reproductive rate of the species and high positively correlation between the species. When comparing the models through a Bayesian posterior probabilities we can conclude that that semiparametric corrections are less important than the species interactions and temporal variation in the reproductive parameters.

Keywords: Ricker model. stock-recruitment relationship. Weaver Creek spawning channel. Gaussian process models. Bayesian nonparametrics.

*Department of Environmental Sciences, University of Helsinki, Finland
†CSIRO Marine Laboratories, Commonwealth Scientific and Industrial Research Organization, Australia