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Variance partitioning for integrated population models

Integrated population models (IPM) provide a framework for studying population dynamics by combining multiple data sources. IPMs can be used to investigate relations between temporal variation in environmental variables and variation in growth rates, mediated via demographic rates. Such investigations have usually come down to estimating covariate coefficients for the effects of environmental variables on demographic rates. However, a large coefficient does not necessarily imply a large impact on the growth rate if the sensitivity of the vital rate is low, and there have been few assessments of how environmental variation translates into variation in growth rates. Here we extend the transient life table response experiments (LTRE) of Koons et al. 2016, which partitions variation in realized annual growth rates into contributions from vital rates, to further partition the variation into contributions from temporally varying explanatory variables affecting the vital rates. The LTRE decomposition allows us to compare the resultant effect on the growth rate of different environmental covariates that may each act via multiple vital rates, and to compute the amount of variation in the growth rate that they explain. The approach is illustrated by an application to data from a 26 year study on wheatears, a migratory passerine bird breeding in an agricultural landscape. For this population we partition variation in realized growth rates into contributions from temperature, rainfall and population density in the breeding area, and rainfall in the wintering area.