Determining individual variation in growth and its implication for life history and population processes using the Empirical Bayes method

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Abstract: A better understanding of growth will always be an important problem in biology. Variation in growth can have substantial consequences for both ecological and evolutionary dynamics as well as affect the estimation of vital rates and demographic traits, which may translate to incorrect model predictions. However, the implications of including individual differences in growth in the study of population processes are largely unexplored, in part because of the challenges of estimating the determinants and the extent of shared (i.e. among homogeneous groups) and individual (i.e. after accounting for shared component) variation. Our understanding of growth dynamics and of its consequence on population and evolutionary dynamics can greatly benefit from the use of novel and powerful statistical approaches that are able to tease apart the sources of growth variation.
We use an Empirical Bayes (EB) approach to estimate individual and shared variation in somatic growth with a random-effects model. We implemented the EB approach in the module ADMB-RE of the software ADMB and applied the EB approach to the joint estimation of shared and individual variation in growth from longitudinal data using a parameter-rich von Bertalanffy growth (vB) function.
As a case study, we consider two populations of marble trout *Salmo marmoratus* living in Slovenian streams, where individually-tagged fish have been sampled for more than 15 years. We introduce cohort and density during the first year of life as potential predictors of the vB function's parameters k and L_∞ in addition to the individual random effects. We show that our EB approach predicts future growth of organism with substantially greater accuracy than using historical information on growth at the population level, and help us identify year-class effects probably associated with climatic vagaries as the most important determinant of variation in growth.