Estimating density-dependence in vital rates from spatially and temporally replicated counts of unmarked animals

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Abstract: The relative importance of density-dependence regulation is a central issue in theoretical ecology as well as conservation biology. Density dependence is defined as a general tendency of per capita growth rates to decrease when population size is large and increase when it is small. Density dependence influences population growth by affecting survival and\or reproduction. We extend the open N-mixture model of Dail & Madsen (Biometrics 2011) to include density dependence in either survival or recruitment rates alone or in both vital rates. We assess the reliability of our models by simulation. Data are simulated for several scenarios representing different kinds of life histories, population sizes, magnitudes of temporal fluctuation of abundance and density dependence in the vital rates. Beyond demography, environmental stochasticity contributes to the dynamics of a population over time. Hence, we investigate how environmental noise could affect the estimation of strength of density dependence in vital rates. The simulations show that the strength of density dependence in the demographic rates can be estimated. When the model is well specified regarding the different kinds of scenarios, the estimates of the strength of density dependence are more accurate. We apply our model to spatially and temporally replicated counts of Swiss breeding birds obtained from the breeding bird monitoring scheme.

References

Dail, D. and Madsen L. (2011) Models for estimating abundance from repeated counts of an open metapopulation. *Biometrics*, 67:577-587.