Estimating plastic and evolutionary change under density-dependence from time series

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Abstract: The selection pressures on natural populations fluctuate, but observed changes in traits are affected not only by selection but by plastic response to environmental change. Further, selection and plasticity may both alter trait distributions, but do not have equivalent effects on demography. In particular, the cost of viability selection is paid through declines in population number. Thus, observed trajectories of trait value and population abundance depend on interactions between plasticity, selection and the environment. Demographic trajectories also contain limited information about the action of selection. For example, it has long been known that density-dependence can dilute the effect of natural selection on population dynamics (Saccheri and Hanski 2006). Specifically, density-dependent compensation can buffer vital rates from the effects of sustained directional selection (Reed *et al.* 2013). Although recent methods decompose observed trait change into contributions due to evolution and plasticity (Crozier *et al.* 2011, Ellner *et al.* 2011) these methods do not account for the effect of density-dependence on population trajectories, or the partial information contained in demographic trajectories concerning the action of selection.

I develop a method for estimating parameters governing change in trait values due to plasticity and due to response to selection, all in the presence of density-dependence. Working in a hierarchical Bayesian framework, I demonstrate how it is possible to infer the action of plasticity and genetic evolution in the presence of density-dependence from time series of trait and abundance data. Using a simulation study, I illustrate the sensitivity of this inference to informativeness of priors on vital rates and the environmental sensitivity of selection. I then apply my framework to a case study of changes in migration timing of Pacific salmon.

References

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