Using OpenBUGS and lmer to study variation in plant demographic rates over several spatial and temporal scales

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I am using the **lme4** and **R2OpenBUGS** *R* packages to study patterns in temporal and spatial variation in vital rates of the forest herb *Lathyrus vernus*. The combined effect of vital rate variation on population dynamics is examined in an Integral Projection Model (IPM), also run in *R*. Hierarchical plant demographic studies only recently became practically possible and have rarely been performed previously (Buckley et al. 2003), but available modeling techniques now enable such approaches (McMahon & Diez 2007, Evans et al. 2010). Understanding where variation occurs can shed much light on what factors affect plant demography. In contrast to previous studies I also use *Openbugs* and `lmer` to examine at what spatial scales temporal variation occurs. In addition to this study of variance components, I attempt to determine which out of a large set of environmental factors that were measured at the plot level have the largest effect on population dynamics. This is done by including Bayesian lasso components into the *OpenBUGS* vital rate models (Tibshirani 1996, Yi & Xu 2008).

Preliminary analyses suggest that most of the variation of all vital rates occur at the scale of individuals, as opposed to plot or sub-population scales. Temporal variation seems to be equally distributed over spatial scales. Environmental factors have differing effects different years and are generally weak. This is in accordance with the fact that little variation occurred at the plot scale, where environmental factors were measured. I discuss the potential of density dependence to cause observed patterns.

On the technical side, I conclude that apart from the obvious "limitations" of a specialized function of not easily allowing utilization of techniques such as the Bayesian lasso used here, at least two aspects of lmer should make it an often more desirable choice than OpenBUGS for ecologists planning similar analyses (see also Gelman & Hill 2007). First, as seen from comparisons with our *BUGS* models, it is very accurate - even when estimating variance components for factors with few levels. Second, it is much faster than OpenBUGS, not only in computation time of correctly specified models, but because of the time it can take to specify a working *BUGS* model.

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