(Excerpt from chapter 13 of *Ecological Statistics: Contemporary theory and application* eds. Fox, Negrete-Yankelevich, Sosa, Oxford University Press 2015)

13.6.3 Reporting the GLMM results

Graphical summaries of statistical analyses that display the model coefficients and their uncertainty, or that overlay model predictions and their uncertainties on the original data, are important (Gelman et al. 2002). However, you also need to summarize the results in words. This summary should include the magnitudes and confidence intervals of the fixed effects; the magnitude of the among-group variation for each random effect, whether it is of primary interest or not; and possibly the confidence intervals of the among-group variation (if the random effects are included because they are part of the design, you should *not* test the null hypothesis that they are zero). If you are interested in the partitioning of variance across levels, report among-group variation as random-effect variances, or proportions of variance (see the grouse tick example below). If you are more interested in the fixed effects, report among-group variation as random-effect standard deviations, as these are directly comparable to the corresponding fixed effects. The following are sample reports for the four worked examples; Appendix 13A shows the technical details of deriving these results.

- *Tundra carbon*: The main effect of interest is the across-site average change in growing season carbon flux per year; the estimated slopes are negative because the rate of carbon loss is increasing. Our conclusion from the fitted model with the year variable centred (i.e., setting `Year=0` to the overall mean of the years in the data) would be something like: "the overall rate of change of growing season NEE was -3.84 g C/m^2/season/year (t_{23}=2.55, p=0.018, 95% CI={6.86, 0.82}). We estimated a first-order autocorrelation within sites of r=0.39; among-site variation in the intercept was negligible, while the among-site standard deviation in slope was 5.07 g C/m^2/season/year, with a residual standard deviation of 58.9 g C/m^2/season."

- *Coral symbionts*: For the analysis done here (logit link, one-way comparison of crab/shrimp/both to control) we could quote either the fixed-effect parameter estimates (clarifying to the reader that these are differences between treatments and the baseline control treatment, on the logit or log-odds scale), or the changes in predation probability from one group to another. Taking the first approach: "Crab and shrimp treatments had similar effects (-3.8 log-odds decrease in predation probability for crab, -4.4 for shrimp); the dual-symbiont treatment had an even larger effect (-5.5 units), but although the presence of any symbiont caused a significant drop in predation probability relative to the control (Wald p-value 0.0013; parametric bootstrap p-value < 0.003), none of the symbiont treatments differed significantly from each other (likelihood ratio test p=0.27, parametric bootstrap test (N=220) p=0.23); in particular, two symbionts did not have significantly greater protective effects than one (Wald and PB p-values both » 0.15). The among-block standard deviation in log-odds of predation was 3.4, nearly as large as the symbiont effect." (McKeon *et al.* 2012 present slightly different conclusions based on a model with a log rather than a logit link.) Alternately, one could quote the predicted predation probabilities for each group, which might be more understandable for an ecological audience.

- *Gopher tortoise*: The main point of interest here is the effect of prevalence on the (per-area) density of fresh shells. This makes reporting easy, since we can focus on the estimated effect of prevalence. Because the model is fitted on a log scale and the parameter estimate is small, it can be interpreted as a proportional effect. For example: "A 1% increase in seroprevalence was associated with an approximately 2.1% increase (log effect estimate=0.021) in the density of fresh shells (95% CI={0.013,0.031} by parametric bootstrap [PB]). Both of the years subsequent to 2004 had lower shell densities (log-difference =-0.64 (2005), -0.43 (2006)), but the differences were not statistically significant (95% PB CI: 2005={1.34,0.05}, 2006={-1.04,0.18}). There was no detectable overdispersion (Pearson squared residuals/residual df=0.85; estimated variance of an among-observation random effect was zero). The best estimate of among-site standard deviation was zero, indicating no discernable variation among sites, with a 95% PB CI of {0,0.38}."

- *Grouse ticks*: In this case the random effects variation is the primary focus, and we report the among-group variance rather than standard deviation because we are interested in variance partitioning. "Approximately equal amounts of variability occurred at the among-chick, among-brood, and among-location levels (MCMCglmm, 95% credible intervals: s^2_{chick}=0.31 [95% CI {0.2,0.43}, s^2_{brood} =0.59 {0.36,0.93}, s^2_{location}=0.57 {0.29,1.0}). The among-brood variance is estimated to be approximately twice the among-chick and among-location variances, but there is considerable uncertainty in the brood/chick variance ratio ($s^2_{\text{brood}}/s^2_{\text{chick}}$ =2.01 {1.007,3.37}), and estimates of the among-location variance are unstable. Year and altitude also have strong effects. In 1996, tick density increased by a factor of 3.3 relative to 1995 (1.18 {0.72,1.6} log units); in 1997 density decreased by 38% (-0.98 {-1.49,0.46} log units) relative to 1995. Tick density increased by approximately 2% per meter above sea level (-0.024 {-0.03,-0.017} log-units), decreasing by half for every 30 (log(2)/0.024) m of altitude."