Likelihood for Seed Production

Growth data is on individual level, while seed data is on stand level, so I will model individual tree radial growth and stand-level seed production by introducing $\mu_{j,sp,y}$, representing the mean radial growth for stand j, species sp, and year y.

For each individual tree i in stand j, species sp, and year y, the observed radial growth is modeled as, with *sigma* being the variance across individuals:

$$\text{Growth}_{j,sp,y[i]} \sim \text{Normal}(\mu_{j,sp,y}, \sigma^2)$$

The seed count for a particular stand j, species sp, and year y follows a negative binomial distribution with mean $\lambda_{j,sp,y}$ and dispersion term ϕ:

$$\text{Seed}_{j,sp,y} \sim \text{NegBinomial}(\lambda_{j,sp,y}, \phi)$$

The modeled seed count ($\lambda_{j,sp,y}$) for stand j, species sp, and year y is:

$$\log(\lambda_{j,sp,y}) = \alpha_0 + \alpha_{sp} + \alpha_j + (\beta_{1sp} + \beta_{1j}) \cdot \mu_{j,sp,y} + (\beta_{2sp} + \beta_{2j}) \cdot \mu_{j,sp,y-1} + \beta_{3sp} \cdot \text{Elevation}_j$$

Where:

α_0 is the grand mean across all species, stands and years;

α_{sp} is the species-specific intercept for species sp;

α_j is the stand-specific intercept for stand j;

β_{1sp} is the slope for the relationship between current-year growth and seed production for species sp;

β_{1j} is the slope for the relationship between current-year growth and seed production for stand j;

$\mu_{j,sp,y}$ is the mean growth for stand j, species sp, and year y;

β_{2sp} is the slope for the relationship between previous-year growth and seed production as the lag effect for species sp;

β_{2j} is the slope for the relationship between previous-year growth and seed production as the lag effect for stand j;

β_{3sp} is the effect of elevation on seed production for species sp.

Priors for Random Slopes

$$\beta_{1sp} \sim \text{Normal}(0, \sigma_{\beta_1 sp})$$

$$\beta_{2sp} \sim \text{Normal}(0, \sigma_{\beta_2 sp})$$

$$\beta_{1j} \sim \text{Normal}(0, \sigma_{\beta_1 j})$$

$$\beta_{2j} \sim \text{Normal}(0, \sigma_{\beta_2 j})$$

Where:

$\sigma_{\beta_1 sp}$ and $\sigma_{\beta_2 sp}$ represent the standard deviations for the random slopes at the species level;
$\sigma_{\beta_1 j}$ and $\sigma_{\beta_2 j}$ represent the standard deviations for the random slopes at the stand level.