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:

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

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:

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

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;

$\beta_{1,sp}$ is the slope for the relationship between current-year growth and seed production for species sp;

$\beta_{1,j}$ 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;

$\beta_{2,\text{sp}}$ is the slope for the relationship between previous-year growth and seed production as the lag effect for species sp;

$\beta_{2,\text{j}}$ is the slope for the relationship between previous-year growth and seed production as the lag effect for stand j;

$\beta_{3,\text{sp}}$ is the effect of elevation on seed production for species sp.

Priors for Random Slopes

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

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

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

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

Where:

$\sigma_{\beta_1,\mathrm{sp}}$ and $\sigma_{\beta_2,\mathrm{sp}}$ 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.