**Spatiotemporal Models for Ecologists**

**Spatial analysis of two-stage sampling designs**

Goal: Explore bias resulting from sample-weighting in two-stage sample designs

**Data generating process**

Envision that you have a spatial domain that contains a grid of square grid cells. Simulate variation in numerical densities in each grid cell :

Where , and is simulated using the SPDE method:

Where geostatistical range (distance at 13% correlation) is 3 cells, and with a standard deviation of 1. Next, simulate average body size in each cell:

Where and is again simulated using the SPDE method we assume for simplicity that and (and the resulting precision matrix) are the same as previously. Calculate the population-scale average body size as:

Next, simulate a sampling design, in which 25 cells are chosen randomly without replacement. In each grid cell, the density and average body size are both sampled:

Then fit the same model to these data as was used in the simulation model. Next, calculate four estimators for :

1. Sample-average body size as
2. Abundance-weighted body size as
3. Area-weighted model for body size as where is the predicted body size in each cell
4. Abundance-weighted model for body size as

For model-based estimators (#3-4), please record both the plug-in and epsilon bias-corrected estimators, and compare these estimates with the true .

Finally, replicate this experiment 100 times, and record the average bias, average absolute error (AAE) and confidence interval coverage. How do the estimators compare in terms of bias, AAE, interval coverage?