Introduction to Distance Sampling

Analysis with the use of multipliers

The Problem

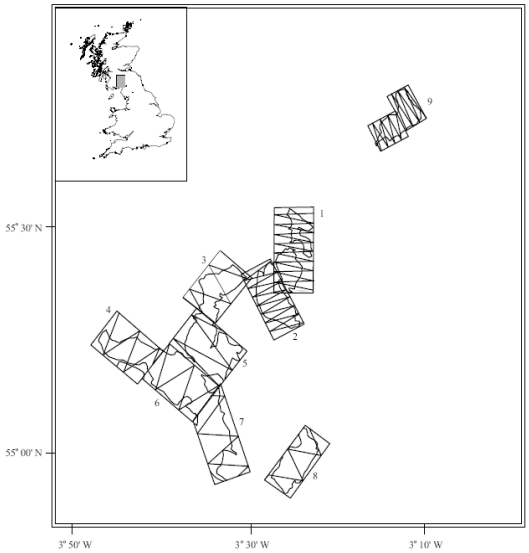
The question is how to estimate of the density of sika deer in a number of woodlands in the Scottish Borders. These animals are quite shy and often will be alert to the presence of an observer before the observer detects them, making surveys of the deer challenging. As a consequence, indirect estimation methods have been applied to this problem. In this manner, an estimate of density is produced for some sign generated by deer (faecal pellets) and this estimate is transformed to density of deer by

$$\hat{D}_{deer} = \frac{\dfrac{\hat{D}_{\text{pellet groups}}}{\text{mean time to decay}}}{\text{dung production rate (per animal)}} = \frac{\text{dung deposited daily}}{\text{dung production rate}}$$

We will produce a pellet group density estimate, then adjust it accordingly to account for the deposition and decay processes operating during the time the data are being acquired. We will also take uncertainty in the production and decay rates into account in our final estimate of deer density.

The Data

Data from 9 woodlands were collected according to the survey design shown below (note differing amounts of effort in different woodlands based on information derived from pilot surveys).



In addition to these data, we also require estimates of the defecation rate. From a consultation with the literature, we learn that sika deer deposit 25 pellet groups daily. The literature source did not provide a measure of variability of this estimate. During the course of our surveys we also followed the fate of some marked pellet groups to estimate the disappearance (decay) rates of a group. A thorough discussion of

methods useful for estimating decay rates and associated measures of precision can be found in Laing et al. (2003).

There are many factors that might influence both deposition and decay rates, and for purposes of this exercise we will make the simplifying assumption that decay rate is homogeneous across these woodlands; with their mean time to decay of 163 days and a standard error of 13 days. However if you were to conduct a survey such as this, you would want to investigate this assumption more thoroughly.

Pay a visit to http://www.wcsmalaysia.org/analysis/Nest_dung_decay.htm where Mike Meredith of Wildlife Conservation Society in Malaysia thoroughly describes an analysis to estimate decay rates for animal nests or dung.

Analysis Exercises

Use the Distance project **Deer pellets.zip** for the following analyses.

1. Adjust the multipliers in the project (replacing the place-holders in the project, with values provided in the previous section of this exercise).
2. Fit the usual series of models (uniform, half normal, and hazard rate) models to the data.
3. Select the Multipliers button in the Model Definition Properties to specify the layer and the field in the project database for the multipliers you wish to employ (along with their measure of precision).
4. Produce estimates using the woodland as strata, pooling data across strata for fitting the detection function, but using woodland-specific encounter rate to produce woodland-specific estimates of density.
5. Produce an overall estimate of density as mean of woodland-specific densities weighted by the effort allocated within each woodlot.
6. Make special note of the components of variance (contribution of detection function, encounter rate, decay rate, and what happened to defecation rate component?) in each of the strata.