Population dynamics II: Practical session II

**Matrix Population Modelling**

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In the second practical, we will construct a stage-based matrix population model for the same house sparrow study system that we met in practical I. We will use data from a single island in the meta-population, Gjerøy, over a 15-year period (1998–2012).

A quick recap on the study system and data collection. The sparrow breeding season runs from May to August in Helgeland. Females lay one to three clutches per season, in nest boxes and in and around farm buildings. Each island is thoroughly checked for nests. Nests are visited two to three times during the incubation and nestling periods and the number of eggs and chicks is recorded. Nestlings are individually marked with metal and plastic colour leg rings when they are 7–12 days old, prior to fledging (leaving the nest). Birds are (re)captured in mist nets throughout the breeding season and in the autumn, and any unringed birds are banded. Sightings of colour-ringed birds are also recorded throughout the spring/summer and autumn field seasons.

**Model structure**

We will use a **post-breeding census** to project the dynamics of the **female** segment of the Gjerøy population from summer year *t* to year *t+1*. We will distinguish three stages based on age – Juveniles: fledglings that hatched in year *t*; Yearlings: hatched in year *t-1*; Adults 2+: hatched in year *t-2* or earlier.

***Task: Draw a life cycle graph with three stages for the sparrows.***Use symbols/letters to denote the transitions among the stages.

(If you are struggling, try drawing a timeline of the annual cycle including census points. Think about how individuals in each of the stage classes counted at census *t* will contribute to the stage classes at census *t+1*. Check back to the lecture slides for a reminder about life cycle graphs for a post-breeding census. See also Kendall et al (2019)).



***Task: Translate your life cycle graph into a 3x3 transition matrix.***This will form the structure of our population projection matrix.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Juvenile | Yearling | Adult |
| Juvenile | ΦJRJ | RYΦY | RAΦA |
| Yearling | ΦJ | 0 | 0 |
| Adult | 0 | ΦY | ΦA |

Once you have completed these tasks, switch to R studio and the html document. Here, we will parameterise a deterministic population model and use the *popbio* package (Stubben & Milligan 2007) to estimate the asymptotic dynamics of our matrix, such as lambda and the stable stage distribution, and conduct prospective perturbation analyses to understand which vital rates have the biggest influence on the population growth rate.

Kendall BE, Fujiwara M, Diaz-Lopez J, Schneider S, Voigt J, Wiesner S (2019) Persistent problems in the construction of matrix population models. Ecological modelling 406: 33-43.

Stubben CJ, Milligan BG (2007) Estimating and Analyzing Demographic Models Using the *popbio* Package in R. Journal of Statistical Software 22 (11).