BIOU9PC: Population and Community Ecology
Lab Practical week 3: Matrix population models
29 September 2016

Objective
The aim of this week's computer lab is to understand, construct and use matrix models to predict the dynamics of age- or stage-structured populations.

Matrix calculations
To better understand the use of matrices to project population dynamics, we will start by constructing a matrix in R. Assume we have 3 age classes, 1-year olds, 2-year olds and 3 years and older (3+). The mean survival probability from age 1 to age 2 is 30% (0.3), the mean survival probability from age 2 to age 3 is 50% (0.5) the mean survival probability of individuals three-year-old or older is 10% (0.1). One-year olds do not reproduce. On average, each 2- or 3-year-old individual produces 1.1 or 4.5 young, respectively. The starting population is 60, with 20 individuals in each age class.

Tasks
1. Build a transition matrix for the Sage Grouse (*Centrocercus urophasianus*) population studied by Johnson & Braun (1999, available on Succeed). Use the mean fecundity and survival data provided in their Table 1. Project the population dynamics forward for 10 years, using an initial population size of 90 grouse, 30 in each of the three age-classes. Plot the projected number of grouse in each age class as it varies through time.
2. Calculate the proportion of Grouse in each age class in the population. How does this change at 1 year, 3 years, 10 years? How do these proportions compare with the stable age distribution of the population model?
3. Plot the observed growth population rate (dN/dt). Add a horizontal line to your graph (*hint:* use abline()) representing λ, the asymptotic population growth rate. How do they compare?
4. What is the elasticity of λ to changes in A? Assess this by multiplying, in turn, each non-zero element of A by 1.1. Make a table with the parameters and the resulting λ's. Identify the parameter with the biggest effect on λ.
5. Assume that we want to boost the abundance of age 3+ birds, perhaps because they're the most fun to shoot. Which element of the transition matrix A most strongly affects the relative abundance of this age-class? Assess this by multiplying, in turn, each non-zero element of A by 1.1 and re-calculating the stable age distribution.
6. Vary the initial age distribution, while maintaining the initial population size at 60 individuals. How do changes in the initial age distribution affect lambda and the stable age distribution?
7. What is the importance of sensitivity and elasticity for conservation and management? How do the two parameters differ in terms of usefulness for conservation and management?
8. When is an age-based model inappropriate? Provide a few examples of populations for which a stage-based model would be more appropriate, and explain why.