WILD 7250 - Analysis of Wildlife Populations
www.auburn.edu/~grandjb/wildpop

Lab 12 – Analyzing matrix models

Submit the Excel spreadsheets with your answers to the following:

Asymptotic dynamics

Consider this 4 age matrix model for a harvested Canada Goose population:

$$\mathbf{A} = \begin{bmatrix} \mathbf{0.000} & \mathbf{0.037} & \mathbf{0.074} & \mathbf{0.185} \\ \mathbf{0.800} & \mathbf{0.000} & \mathbf{0.000} & \mathbf{0.000} \\ \mathbf{0.000} & \mathbf{0.800} & \mathbf{0.000} & \mathbf{0.000} \\ \mathbf{0.000} & \mathbf{0.000} & \mathbf{0.800} & \mathbf{0.800} \end{bmatrix}$$

1. Use PopTools to calculate λ and stable age distribution (SAD) for the population (Use Poptools/MatrixTools/BasicAnalysis). Highlight the value of λ light yellow and the values for SAD in light green.
2. Calculate and label the sensitivities of the matrix (use PopTools/Matrix tools/Matrix sensitivity).
3. Calculate and label the elasticity matrix (E) (use PopTools/Matrix tools/Matrix elasticity).

Ergodicity & Transient dynamics

On the spreadsheet containing the original goose model, you will find 4 projections the population over 25 years (PopTools/MatrixTools/MatrixProjection). These projections start with a population of 1000 females and the following initial age distributions:

- Stable Age Distribution (SAD).
- SAD and removed 80 individuals from adults (ages 4+).
- SAD and removed 80 individuals from ages 1 (juveniles)
- SAD and removed 20% of the individuals from each age class.

At the top of the page there are two graphsPlot N for each project on a single graph. Plot N_{t+1}/N_t for each projection on a separate graph.

5. Answer the following questions:
   a. Does this model display ergodicity? How can you tell?
   b. Which perturbation has the greater impact on transient dynamics? Why?
   c. Under which scenario did the population recover to asymptotic λ most rapidly? Why didn't the 4th scenario cause any transient behavior?
   d. Under which scenario did the population recover to its expected size (i.e. the same as project 1 above?

Perturbation Analysis

The worksheet labeled "Improve Survival," simulates a 1 % improvement in survival of 3 and 4+ year olds ($P_{3,4}$*1.01). **Perform steps 1-3 with this model**.

The worksheet labeled "Improve Repro," simulates a 6% improvement in fertilities for all ages. **Perform steps 1-3 with this model**.

6. Compare λs of each model. How could these results have been predicted by examining e_{ij} of the original model?
7. What are the implications in terms of e_{ij} of improving survival of adults or fertility of all age classes?

LTRE

8. On the worksheet labeled "LTRE" there is another goose model using the survival rates in step 1 and fertilities in step 2. This LTRE was follows the steps described in the lecture notes to compare this model (the treatment) with the original goose model (control). Interpret the results.

Stochastic model

On the sheet labeled stochastic is an example of a stochastic matrix model based on the goose model. Cells A3:D6 are the matrix model. Cells G4:J6 are the logits (βs) and 95% CLs on the rates. The CLs presented here are based on process variation (σ^2). Cells A39:E65 simulate random normal variation in the βs based on the σ (SE) over a period of 25 years. CellsG41:V65 is a row transformed representation of the stochastic matrix of fertilities and survival rates calculated from the simulated βs. Cells A70:E94 is the projection of the matrices over the 25 years using the stochastic values. G70:H94 are the population sizes from the stochastic (N(s)) and deterministic (N(d) projection.

Find the asymptotic population growth rate (provided in the basic analysis), the elasticity matrix, and the estimate of the stochastic growth population growth rate.

9. Use the simulation tools in Poptools to calculate the mean and 95% CLs on λ based on the provided estimates of the βs and SEs for at least 500 trials. Double the SEs on the Fs and repeat the simulation. Return the SEs on the Fs to the original values and double the SEs on P and repeat the simulation. Briefly in the text box provided compare the results of the first simulation to the asymptotic model and explain the effects of increased variation in process variation on expected population growth rate.