

Math 151 - Fall 2004 - Project #4

The Leslie Population Model in a Random Environment:

Consider the Leslie model of a population with three classes (call them J for juveniles, Y for young adults, and A for adults) used in Project #3. Suppose the population starts at time zero with 40% in the J class, 35% in the Y class and 25% in the A class and there is a total of 100 individuals present then. Suppose that the population projection matrix is:

$$P = \begin{pmatrix} 0 & 1 & F \\ .5 & 0 & 0 \\ 0 & q & 0 \end{pmatrix}$$

where the parameter q is calculated by

$$((\text{your age in years})/50 + (\text{the number of your birthmonth})/12) / 2.$$

Thus if you were born in July of 1967, so you are 25 years old,

$$q = (25/50 + 7/12) / 2 = .542 \quad (\text{use three significant digits, please}).$$

Now suppose the adult fecundity F varies from year to year according to a uniform distribution, with an average value of 5 and with a deviation about that, so that the fecundity varies over the interval $(F-\text{deviation}, F+\text{deviation})$

Making use of the Matlab code in the file `ranleslie.m`, do the following:

Calculate your value of p and for values of deviation of 1, 2, 3, and 4:

- Determine the population size at the end of a time period of length 101, repeat the experiment 200 times and compute the mean and standard deviation of population size at time 101, and show a histogram of it's values.
- Determine the geometric mean growth rate of the population's total size by computing this over the single time-step growth rates from time 20 to time 100, repeat the experiment 200 times and compute the mean and standard deviation of the geometric mean growth rate, and show a histogram of it's values.
- Summarize your results in a chart for the cases of deviation =1,2,3,4, showing the means and standard deviations computed in (a) and (b). Discuss these results and in particular describe how a larger random variation in fecundities affects the population size and the geometric growth rate.