

Project 2-Math 261

Spotted Owl Problem Eigenvalues and Eigenvectors Due Nov.19,2008

In class we discussed the population dynamics of the Northern Spotted Owl residing in the Pacific Northwest forest. The formulation began by dividing the spotted owl population into three age cohorts; [Juvenile (J), Sub-Adults (S), Adults (A)] The model then utilized a Leslie Matrix of the form:

$$A = \begin{bmatrix} 0 & F_s & F_a \\ P_j & 0 & 0 \\ 0 & P_s & P_a \end{bmatrix}$$

where F_s, F_a = fecundity of sub-adults and adults respectively and
 P_j, P_s, P_a = probability of survival for juveniles, sub-adults, and adults.

The population can then be modeled by the dynamic equation:

$$\begin{bmatrix} J^{t+1} \\ S^{t+1} \\ A^{t+1} \end{bmatrix} = \begin{bmatrix} 0 & F_s & F_a \\ P_j & 0 & 0 \\ 0 & P_s & P_a \end{bmatrix} \begin{bmatrix} J^t \\ S^t \\ A^t \end{bmatrix}$$

The original research determined the following parameters for the Leslie Matrix:

$$\begin{aligned} F_s &= 0 \\ F_a &= .33 \\ P_j &= .18 \\ P_s &= .71 \\ P_A &= .94 \end{aligned}$$

An updated spotted owl data gives the new parameters for the Leslie Matrix:

$$\begin{aligned} F_s &= .125 \\ F_a &= .26 \\ P_j &= .33 \\ P_s &= .85 \\ P_A &= .85 \end{aligned}$$

To Do:

- 1) Use Microsoft Excel or any other graphing utility to graph the population of the spotted owl as a function of time steps t for both parameter sets. Do you think the spotted owl is better or worse off than before. Explain your answer. (25 points)

- 2) Determine the eigenvalues and eigenvectors of the Leslie matrix for the second parameter set. (30 points)

- 3) Write the initial population $X_0=[10000,4000,25000]$ as a linear combination of the eigenvectors determined in part 2. Use this to write the eigenvalue decomposition of X_k . Finally, use this decomposition to determine the long term ($k \rightarrow \text{infinity}$) population of the spotted owl.
(hint: follow the steps discussed in class) (30 points)

- 4) Try to find the minimum P_j so that the spotted owl population will decline for the second parameter set. Explain your method this could be solved analytically or just by guessing. (30 points)

- 5) Do you think this model is an effective way to estimate long-term population dynamics. What would you add to make the model more realistic?

Note: Although these problems can be solved analytically I strongly encourage you to solve these either using your graphing calculator, Maple, or some other software. Please explain how you came about your solutions.