BIOL 763 / SCCC 411B Midterm Exam Name:_______________________
Fall, 2001

You may use any of our Maple worksheets, or your own, for computations. Be sure to supply adequate explanation for your answers. In many of the problems the later parts do not depend heavily on the earlier parts, so don't give up on (c) if you didn't get (a) or (b)! There are 100 points total.

1. (28 points) Give brief definitions of the following terms. Use pictures, graphs, etc. as needed.
   a. eigenvalue-eigenvector pair

   b. difference equation

   c. unstable equilibrium

   d. Malthusian growth

2. (7 points) Explain how one age class can have higher reproductive value than another, even though it has lower fecundity.

3. (20 points) Modify the continuous logistic model to account for harvesting (which amounts to removal of population) under two different regimes: a fixed amount H per time period, and a fraction α of the current population. In each case determine any non-trivial equilibrium values. What happens if $H > rK/4$ or $\alpha > r$ respectively?

4. (15 points) A certain population has three life stages: juvenile, subadult, and adult. Survivorship from juvenile to subadult is unknown, but is in the range $0.18 \leq s \leq 0.30$. Otherwise the transition matrix is known: $A = \begin{bmatrix} 0 & 0 & 0.33 \\ s & 0 & 0 \\ 0 & 0.71 & 0.94 \end{bmatrix}$. Actually 60% of juveniles survive to leave the nest, but between 50% and 70% of these fail to to find adequate breeding territory and/or mates. If we are interested in conservation of this species, then we need to know how large s must be to at least maintain the species, and better yet to see it grow. Determine this value.

5. (30 points) The Leslie-Lefkowitch matrix for a certain population model with classes I, II, III, and IV is $A = \begin{bmatrix} 0 & 0.5 & 4.0 & 0 \\ 0.9 & 0 & 0 & 0 \\ 0 & 0.8 & 0 & 0 \\ 0 & 0 & 0.3 & 0.2 \end{bmatrix}$

a. If the current population consists of 100 individuals in class II, how many individuals will be in each class two time steps from now?

b. The dominant eigenvalue for this system is $\lambda = 1.53$, and the corresponding eigenvector is $[0.51, 0.3, 0.16, 0.04]$. There is another real eigenvalue 0.2 and a pair of complex eigenvalues of magnitude 1.37. Use this information to answer the following questions. Justify your answers! Over the long term does the population grow, decline, or remain stable? What is the long term distribution of the population in percent terms? What kind of transient population dynamics do you expect to see?

c. What happens if you start with 100 individuals in age class IV? Is the result consistent with the general mathematical theory and with biological common sense?