**FISH 458/558 - Fish Population Dynamics**

**LAB ASSIGNMENT #4 (Leslie Matrix Models)**

*Complete and return your assignment (via Canvas) in the form of a Word document (with any answers and figures requested and with the R script copied in).*

*Guidelines:*

* *Include the course, lab number, and date at the top of the file (but not your name)*
* *Number and label the questions and answers clearly! (We should easily be able to find your answers!)*
* *Include all of the requested output (e.g., values, data tables, and plots), not just the code for them. (We will not copy your code into R to see if it works).*
* ***Include informative captions for figures and tables.***
* *Submit a Word document unless directed otherwise (no r files or pdfs please).*
* *Include all your code used for the problems.*
* *Answer ALL questions using complete sentences that are clear and informative.*

**Part A. Leslie Matrices (30 pts)**

1. We want to model a population of fish (ages 1 – 5; using the females) that has a maximum age of five years. The fish are immature at age 1, 50% mature at age 2, and fully mature at ages 3, 4, and 5. On average, a mature female produces 1.5 female offspring that survive to age-1 per year. Annual ***mortality*** rates of ages 1 through 4 are 0.6, 0.5, 0.4, 0.4 per year, respectively. This species does not survive past age 5, so the survival of age-5 is zero.
   1. Draw a conceptual diagram (with arrows and parameters) for this situation. You can design this on the computer, or you can hand-draw it and add a picture. Don’t forget to include a figure caption here (and for all plots). (3 pts)
   2. Write out the equations (with symbols, not specific values) that show how to calculate the abundance for each age class at time t+1 (e.g., ) and describe what those equations mean. Try to do this without looking at the notes at first to help solidify the concept in your mind! (3 pts)
   3. What is the fecundity for each age (fa)? [**HINT**: Remember that fa is the average fecundity for *all* individuals of that age, and not only the individuals that are mature. You will need to calculate fa using the information in the problem above.] (3 pts)
   4. Create (and show) the Leslie matrix with the appropriate parameter values. [**HINT**: remember that *mortality* is not equal to survival.] (3 pts)
2. We sampled the population and found that there were 100, 65, 42, 20, and 11 females ages 1-5, respectively, in the population of Mud Pond. Simulate the population trajectory for 15 years.
   1. What is the population growth rate? Describe whether the population is increasing or decreasing, and by what percentage per year? (Make sure you are clear and accurate with your wording.) Describe how the population growth rate was calculated. (3 pts)
   2. Create a single plot that depicts the total abundance (not log-transformed) through time. (3 pts)
   3. What is the stable age distribution for this population? Include a graph, but also provide the specific estimates for each age. (3 pts)
3. Conduct an elasticity analysis on your Leslie Matrix.
   1. What is elasticity? (1 pt)
   2. Which single parameter would you recommend we work towards changing if our goal is to try and recover the population in Mud Pond, and why? In your answer, be sure to explain what your exact elasticity values mean. (2 pts)
4. We have found that we can decrease **mortality** of age-1 fish to 50% per year by aerating the pond in the summer. Simulate the population trajectory for 15 years and create a new plot of the total population. How does this change the population dynamics? Be explicit and provide the new lambda. (4 pts)
5. Get together with at least one person from this class (outside of our lab period). Discuss your answers & code, fix any errors you may have, and ask any questions you might have. Take a selfie of you together, screen shot of your zoom, or some other evidence that you did this and include it with your HW. Explain whether this was helpful and why, and include your “evidence”. (2 pts)
6. How many hours did you spend on this assignment as a whole? (558 students should indicate the amount of time they spent on each of the two components: the 458 part and the 558 part).

458 part: 1 hr so far

558 part:

**558 Students (8 pts)**

1. Find and read a peer-reviewed paper that models a population of an aquatic (non-terrestrial) animal using a Leslie matrix model (aka Life Cycle Model) or one of its variants (e.g. Lefkovitch Model).
   1. Provide a synopsis (<300 words) that includes the purpose/background of the study, a brief description of the model they used (e.g., number of ages/stages), any modifications to the standard Leslie matrix model (e.g., plus group, stage-based model, density-dependent parameters, etc.), and their conclusions. Also provide the citation for the article and a web link to the article. (6 pts)
   2. What did you find interesting about the paper? What did you not understand or follow? (2 pts)