EEB 610 240: Homework 1
Due Tuesday Sept. 18th

Name: _____

- Please show your work when answering a question.
- Don't waste your time drawing figures on a computer. Just sketch it out by hand.
- Don't waste your time typing your answers, legible handwritten responses are fine.
- My expectation is that this homework will take two to three hours to complete. I am unsure how realistic this expectation is. If you find that it appears like it will take longer than than three hours, please come talk to me.
- You are encouraged to help each other and discuss the problems in the homework, however, what you turn should be your own work.
- If you are having problems, getting stuck on a particular point or don't understand a question, please drop me a line.

Gotelli (2002)

Chapter 1 Please answer questions 2-5. For question 3, estimate r for each of the time steps and calculate the mean and variance of these values.

Model Formulation and Analysis

1. You are interested in a population of long lived organisms where births and deaths are negligable over the timespan of interest but emigration and immgration can affect the population size.

   (a) Formulate a recursion equation that describes how the population changes over time where m and n represent the immigration and emigration rates explicitly.

   (b) Derive the general solution for the model (i.e. write N_t as a function of the basic model parameters).

   (c) What are the conditions for the population to be increasing over time?

   (d) Assuming that the conditions for population growth are met, using your solution above solve for when the population will be double in size.

   (e) Assuming that the conditions for population decline are met, solve for when the population will go extinct.

(f) All models are approximations and, therefore, wrong. What is one unrealistic behavior of this model for a declining population? What assumption might you modify to rectify this unrealistic behavior?

(g) Using your recursion equation, derive the analogous continuous time model for this system.

(h) Solve the continuous time model.

(i) Compare the solutions of the discrete and continuous time models. Do your solutions differ? If they do, explain why. If they don't, explain why, unlike the other models we looked at, they do not.

2. A more general of population growth includes: births, deaths, emigration, and immigration. One formulation of such a model is,

$$\frac{dN}{dt} = m + bN - dN - nN \tag{1}$$

(a) What is the *per capita* rate of population increase in this model? How does it differ from the standard exponential growth model?

(b) Using the fact that $\frac{dln(x)}{dx} = \frac{1}{x}$ (which implies that $\int \frac{1}{x} = \ln(x) + C$), the chain rule $\frac{dg(f(x))}{dx} = \frac{dg}{df}\frac{df}{dx}$ find the solution for the model above.

(c) Assuming that r is positive and that t is sufficiently large such that $e^{rt} \gg 1$, what is the impact of including emigration and immigration on the solution of the model?

(d) How does this model differ from the sink population model discussed in class?

(e) If you evaluate the model under parameter values that make it consistent with the sink model is the model solution the same?