QS2: Population Ecology
Due: start of class on 11/18

Please work with your group to complete the following questions. Turn in one response as a group, along with accompanying R code. Several questions are marked as OPTIONAL – I'd encourage you to think about them, and maybe try a few of your choosing.

In addition to submitting the group assignment, please also send me *as individuals* a short (2-5 sentence?) description of your contributions to the group assignment, and what you learned from it, and how you challenged yourself. Note: there are many important ways to contribute to groups! Learn from each other, challenge each other, try to communicate clearly (follow advice in Shoemaker et al.)

Questions:

A modification of the logistic growth model in discrete time is the theta logistic model:

$$x(t+1) = r \cdot x(t) \cdot \left(1 - \left(\frac{x(t)}{K}\right)^{\theta}\right)$$

1. Use R & techniques covered in the R Bootcamp to assemble this discrete time model. Make a plot illustrating population dynamics given this model over 20 years (time steps), assuming that starting parameters are: r = 1.2, K = 100, θ = 1 and x(0) = 2. Hint: recall what you learned about using for() loops.

2. Modify the above model to demonstrate what happens for at least 3 different values of θ. Provide plots and text interpreting the plots, and addressing the effects of θ on the strength of density dependence in this model.

An alternative model incorporates the potential for an Allee effect:

$$x(t+1) = r \cdot x(t) \cdot \left(\frac{x(t)}{A} - 1\right) \cdot \left(1 - \frac{x(t)}{K}\right)$$

3. Implement this model in R. Model population dynamics over 30 time steps, assuming parameter values: r = 1.2, A = 5, K = 100. Consider what happens to the population as a function of varying the initial population size (ie, the value of x(0)). Under what conditions does the population grow? Go extinct?

4. What does parameter A do in this model?

5. OPTIONAL: Consider what would happen if you add immigration to this model. Can you contrive a scenario where a population that would otherwise go extinct due to the Allee effect is able to persist due to immigration?

Consult the provided R script, examine the simulation model of Stacey & Taper 1992

6. Can you replicate their assessment of the effects of variability? (in particular, what happens if you remove the variability? pg. 21). Take the model above, and replace the random draws of s.A, s.J, and fecundity with their mean values. Run the simulation again. How does the distribution of extinction times change?

7. Pick out one of the assumptions of the paper, change it, and describe/illustrate what happens.

8. Is the basic simulation model actually completely density independent? hint: try calculating how many individuals are lost from the population each year (mortality + emigration), and produce a plot of this rate of loss against population density.

OPTIONAL:

9. What would happen if the sex-ratio of the population was not assumed to be 50:50? What are some different ways that this might occur? Can respond in writing, or supplement with quantitative results.

10. Can you figure out how Stacey & Taper calculated an overall population growth rate of lambda = 0.95 (on pg. 21)?

11. Did we actually reproduce the original model accurately? Fig. 2 suggests that the maximum time to extinction in their set of 1000 runs was 49 years. How often in sets of 1000 runs do we observe maximum extinction times longer than 49 years?