F&WL 501
Lab 12 – Count-based PVA

In today's lab, we'll use one of the simplest forms of population viability analyses to explore some of the concepts, uses, and pitfalls of PVA. The data are counts of female grizzly bears with cubs-of-the-year in the Greater Yellowstone Ecosystem during 1983-2008. The data are provided in the Interagency Grizzly Bear Study Team's Annual Report for 2008, which is at: http://www.nrmsc.usgs.gov/files/norock/products/IGBST/2008report_1-15-2010.pdf

We will look at 2 methods of evaluating the quasi-extinction risk for the number of female grizzly bears with cubs-of-the-year: (1) a simulation-based approach and (2) the diffusion-approximation method. The 1st method will be our primary focus and you can see how it works in the R code provided for today's lab. The 2nd method is overviewed in Chapter 3 of Morris and Doak (2002; [Morris, W. F., and D. F. Doak. 2002. Quantitative conservation biology: Theory and practice of population viability analysis. Sinauer, Sunderland, Massachusetts, USA.]) and the references therein.

The 2 results from the 2 methods were compared in a recent paper by Kendall (2009; Kendall, B.E. 2009. The diffusion approximation overestimates the extinction risk for count-based PVA. Conservation Letters 2:216-225.) and we'll briefly compare the results from both methods in this lab as well.

1. Examine PVA.counts.r and report the *mean* and *sd* of the ln(λ) values calculated from the reported bear numbers.
2. Look at the actual ln(λ) values and describe why you think that these numbers are so variable. Given that, is it reasonable to base the PVA on these counts? Why or why not?

Regardless of your answer to #2, we'll carry on and act as if it is reasonable and interesting to do the PVA. And, before we go any further, we ought to also consider that the method here assumes the following (*see page 91 of Morris & Doak's 2002 book for more on this*)

- Constancy in the mean and variance of the population growth rate
    - No density dependence
    - No demographic stochasticity
    - No temporal trends in environmental conditions
- Independence of temporal conditions from 1 year to the next
- No catastrophes or bonanzas
- Error-free counts

Despite those assumptions and the fact that we don't really meet them, we'll carry on for the sake of learning about PVA.

3. Given the modeling done, does it appear likely that the population will grow over the next 25 years? Certain?
4. Is the uncertainty in population size constant through time or not? Explain.

5. Why is the pattern of uncertainty through time so different for ln(N) and N?
6. What is the simulation-based estimate of the probability of going quasi-extinct in t years given a starting population size of 56 and a quasi-extinction value of 25 for values of t from 1 to 25 (note: we really only calculate probabilities for years 2 to 25 as we start at t=1)?
7. Repeat the simulation exercise a few times. Does it appear that the values summarized over a single set of 5,000 simulations are reliable? Explain.
8. What happens to the probability of quasi-extinction at $t=25$ when you change the mean value of ln(λ) to ½ of the original value? 2x the original value? Why do you think that this is so?
9. What happens to the probability of quasi-extinction at $t=25$ when you put the mean value of ln(λ) to its original value and put *sd*(ln(λ)) to ½ the original value? 2x the original value? Why do you think that this is so?
10. Which seemed to matter more here, changing the mean value of ln(λ) or the *sd*(ln(λ))?

Reset the mean value of ln(λ) and the *sd*(ln(λ)) back to the original values.

11. What happens to the probability of quasi-extinction at $t=25$ when you reduce the quasi-extinction threshold from 25 to 2?
12. There is a demographic objective of ≥48 females/yr with cubs-of-the-year. What is the chance of going below that number for t=2 to 25? Note: here we are getting closer to something that's a more reasonable use of the data at hand while still using the same tool.

First, remove 1 comment mark (#) from each of the last 8 lines of code. Then using a quasi-extinction threshold of 25, and with the mean value of ln(λ) and the *sd*(ln(λ)) set at their original values, work out the following.

13. Run all of the code and examine the table and graph. For this scenario, does the diffusion approximation method estimate a higher or lower extinction probability than does the simulation approach? Does the difference seem important or negligible? Explain.
14. What did Kendall (2009) conclude about the 2 approaches? Which would you use? Why?
15. Based on what Kendall (2009) reported, is count-based PVA used often? For diverse species? Why do you think that this might be so?