WILD 501 – Homework 8
Reproductive Value

“Reproductive value of an individual of age $x$ is a measure of the extent to which it contributes to the ancestry of future generations.” (Roff, D. 2002 – page 69)

“… an optimum life history maximizes for each age class the expected fecundity at that age class the expected fecundity plus the sum of all future expected fecundities, each discounted …” Schaffer 1974 (Ecology 55:291-303)

This week’s assignment has you measure reproductive value from survival and fecundity data in several ways and explores the effects of changes in trade-offs and population growth rates on optimal reproductive effort at a given age.

Part A. Calculating Reproductive value

Work with the following pre-reproductive Leslie matrix

\[
\begin{bmatrix}
0 & 2 & .5 & .1 \\
.5 & 0 & 0 & 0 \\
0 & .6 & 0 & 0 \\
0 & 0 & .5 & 0
\end{bmatrix}
\]

1. Calculate and report asymptotic lambda for the matrix.

2. Calculate and report the reproductive value for each age class based on an eigen analysis.

3. Calculate and report the population size that results from projecting the population 51 years when you start with 10 individuals in any 1 age class and 0 in the other 3 ages (provide the final population size for each of the 4 options).
   a. Start with only 10 in “a” yields
   b. Start with only 10 in “b” yields
   c. Start with only 10 in “c” yields
   d. Start with only 10 in “d” yields

4. Divide the results from #3 above by the number obtained when you started with only 10 in the youngest age class and report the results. How do these values compare to those obtained in #2.
5. Use the equation \( V_x = b_x + \frac{s_x}{\lambda} V_{x+1} \) that's presented on page 185 of your textbook to calculate \( V_x \) for ages 1 through 4 (use a value of 1.0 for \( s_0 \); it's not all that realistic but matches what's done on page 185 and let's you substitute the \( F_x \) values in for your \( b_x \) values). Fill in the following table and note how your standardized values for \( V_x \) compare to values obtained in #2 and #4 above.

<table>
<thead>
<tr>
<th>Age (x)</th>
<th>( s_x )</th>
<th>( b_x )</th>
<th>( \frac{s_x}{\lambda} V_{x+1} )</th>
<th>Raw ( V_x )</th>
<th>( V_x ) standardized so that ( V_1 = 1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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6. Which of these methods provides you with the most intuitive sense of what reproductive value is?

7. Which of these methods is the easiest to calculate?

8. Which of these methods provides you with the clearest information on current versus future (or residual) reproductive value?

Next, work with the file PiankaParker.R and answer the following questions.

9. Are there tradeoffs between fecundity at age \( x \) and residual reproductive value depicted in the curves created by the code? And, if so, how do the tradeoffs differ for the convex (concave up) curves versus the concave (concave down) curves?

10. For the curves in the left-hand column of each graphic (plot of fecundity at age \( x \) versus residual reproductive value), why is it appropriate to have the slope of the blue line be the same as the negative value of lambda?

11. For the convex curves, are there any scenarios for which you expect selection to favor any current reproductive effort? If so, describe that scenario and explain why it makes biological sense for there to be some current reproductive effort at the age in question.

12. In general terms, how does optimal reproductive effort differ when you switch to the concave curves?

13. For the concave curves, how does changing the population growth rate affect the optimal reproductive effort? Explain in words why this should be so.