Assignment 5: Life-table Methods

Manatees, dugongs and sea cows are peculiar marine mammals with a relictual geographical distribution that includes the West Indian Ocean, Florida, the Amazon River basin, and until early in this century the North Pacific. They are difficult to study and the life table data assembled by Packard (1985) for female West Indian manatees *Trichechus manatus* is preliminary.

Age (yrs)	l_x	Age (yrs)	l_x
1-6	0.955	31-36	0.540
7-12	0.860	37-42	0.345
13-18	0.830	43-48	0.144
19-24	0.780	49-54	0.027
25-30	0.690	55-60	0

Objective: The purpose of this assignment is to review the calculations of life tables and to familiarize yourself with some of the features of the spreadsheet Excel. A couple of commands that you will need to know to complete this assignment:

putting an apostrophe before a string enters it as text
e.g., typing ‘1-6 will put 1-6 into a cell.

typing =b5 into cell c5 returns the contents of cell b5 into c5. Copying the formula from c5 into cell c6 will yield =b6. To anchor the cell you want to copy put a dollar sign in front of the column and row reference by typing =b5.

=sum(d2:d11) returns the sum of the cell contents in cells d2 to d11
=ln(b13) returns the natural logarithm of the number in cell b12
=exp(number) returns e raised to the power of a given number

Calculations and Questions

1. To get started, set up a spreadsheet by typing labels into each cell as follows:A1=Age, B1=x, c1=lx, D1=mx, E1=lxmx, F1=xlxmx, G1=lxmxe-(rx) and H1=vx. Enter the ages in the A column (cells A2 to A11), number the x values from 0 to 9 in the B column and enter the lx values in column C.
a) Note that lx does not start with 1.0, does this pose a problem?

2. Calculate mx from the following information. Female manatees begin to reproduce at age 7. The average proportion of mature females that breed each year is 0.61, litter size can be assumed to be 1 calf and the interbirth interval is generally 2 years.
a) What are the units of m_x? Remember that life tables are based on female demography and this must be accounted for in the calculations.

3. Do the calculations to fill out columns E and F. Enter the labels Ro, T and r_{est} into cells A13 to A15. Using the following formulae, calculate the net reproductive rate (R_0), generation time (T), and an estimate of the instantaneous growth rate r_{est} and put these in cells B13 to B15.

$$R_0 = \sum_{x=0}^{w} l_x m_x \qquad T = \frac{\sum_{x=0}^{w} x l_x m_x}{R_0} \qquad r = \frac{\ln R_0}{T}$$

a) Is the population growing?
b) The time step in the life table is 6 years, what is the generation time and estimated growth rate *in years*?

4. You are now set to calculate the population growth rate with the Euler-Lotka equation. Enter the labels r and Sum into cells A18 and A19. Put a starting value for r into cell B18. Using the following formula for the Euler-Lotka equation complete the calculations for column G.

$$1 = \sum_{x=0}^{w} l_x m_x e^{-rx}$$

Calculate the sum of column G and put the result in B19.
Solve for r by iteratively adjusting the value in cell A18 until the sum in A19 is equal to one. Make a note of the value for r that you obtain, then change r back to your starting value. Next, try a feature of Excel to solve this problem. Go to Tools | Solver and pull up the menu. In the field that says 'By changing cell' enter B18 and in the field that says 'Subject to the constraints' enter B19=1. Click on 'Solve' and see what happens.
a) Do the two methods give the same value of r?
b) How does the value of r from the Euler-Lotka equation compare to r_{est}? If there are differences, what might these be due to?

5. The last step is to calculate the age-specific reproductive value (v_x). The formula for v_x is:

$$v_x = \sum_{y=x}^{w} \frac{l_y}{l_x} m_x$$

To remind yourself of the mechanics of these calculations examine the footnote of Table 4.1 from Pianka (given as a handout and also in the reader).

Here is a trick to save you some typing. Enter the following formula into cell H10 =1/C10*(C10*D10). If you have used a slightly different table layout, and the row for x=8 is different you will need to adjust the cell addresses accordingly. Copy this cell into the row above and modify it by adding in the ltmt product for that row. Then copy that cell into the row above and repeat. Reproductive values are usually scaled relative to the first age class by dividing all v_x values by value for the youngest age class (v_0)
a) What age-class of females has the greatest reproductive value?
b) How might this affect conservation plans for this species?

Hand in: A copy of your spreadsheet and short answers to all of the questions in this exercise.

Packard, JM 1985. Preliminary assessment of uncertainty involved in modeling manatee populations. Manatee Population Research Report No. 9, Tech. Report No. 8-9. Florida Coop. Fish and Wildlife Res. Unit, Univ. of Florida, Gainsville, Florida. 19 pp.