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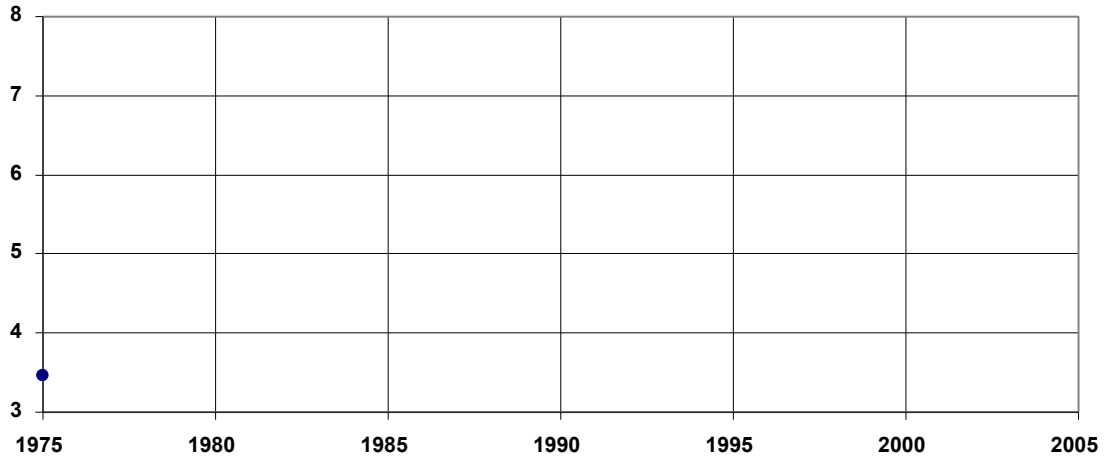
BIOE 107 Ecology Problem Set 1 Population models

1) The yearly instantaneous (continuous time) survival rates and birth rates in Israel over the last 35 years are given by the table below.

Year	Survival rate	Birth rate
1975	0.9929	0.0282
1980	0.9933	0.0241
1985	0.9934	0.0235
1990	0.9938	0.0222
2005	0.9938	0.0182

a) If immigration and emigration were balanced over this period, would you expect the population in Israel to grow over this period? Why?

b) Using excel and an equation for continuous time population growth, make a graph of the population from 1975-2005 using the data above and a starting population size of 3.455 Million. Draw the result on the graph below, label the X and Y axes, and write the population size above each point for each of the four years given in the table above.



c) Is the per capita population growth **rate** in Israel over this period: a) increasing or b) decreasing? Explain.

d) How can you reconcile the result from (c) with the fact that the survival rate has increased over this time period?

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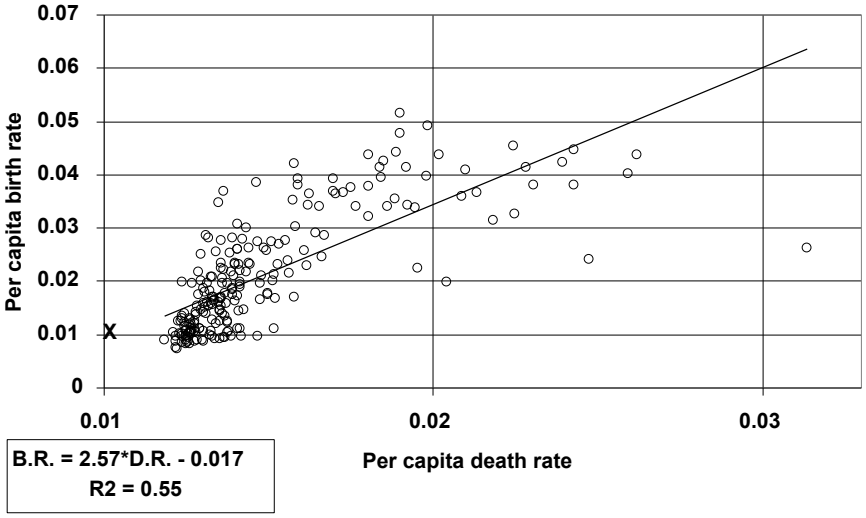
Extra credit (e&f). The birth rates (B.R.) and survival rates (S.R.) for 219 countries are shown in the graph below and the best fit line to the data is given in the lower left hand corner.



e) Describe how this pattern agrees or disagrees with the result from (d).

f) Finally, draw a line starting from the X in the lower left of the graph that would be required such that increasing survival rates had NO effect on total population growth rate.

2) *Trillium grandiflorum* is a beautiful flowering plant in the eastern USA that grows under the closed canopy and is a favorite plant of deer. An overabundance of deer is hypothesized to be the cause of declining populations of Trillium. Use the life table below and excel to determine whether the data support this hypothesis.

Age (x)	Number Alive N(x)	Survival rate, S(x) or g(x) (x to x+1)	Survivorship, l(x) (0 to x)	Birth rate, b(x)	l(x)b(x)	l(x)b(x)x	Stable age Distribution, c(x)
0	455			0			
1	127			0			
2	42			0			
3	34			0			
4	33			4.5			
5	20			12.5			
6	0			0			

a) Fill in the table using the data and the equations given in class or Gotelli.

b) What is the "net reproductive rate", R_0 for this population of Trillium?

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R_0 = Equation used: R_0 =

c) Is this population growing or declining, or stable? Explain.

d) What is the "generation time", G for this population of Trillium?

G = Equation used: G =

e) What is an approximate value for r?

r ≅ Equation used: r ≅

f) What is the stable age distribution of Trillium given the data in the table? Insert your answer into the last column. What equation did you use?

c(x) =

g) A careful analysis of the plants studied to create this lifetable suggested that of the 13 plants of age 4 that died, 5 of them were browsed by deer and this likely caused their death. If you assume that these plants all would have survived (giving 25 in age 5), what would the net reproductive rate, R_0, for this population of Trillium have been without deer browsing? Does this support the idea that deer are causing the decline of this population of Trillium?

R_0 =

h) Fill in the "Leslie Matrix" that can be used to project the population in each age into the future using the data from the table above. Use this matrix to project the population forward one time-step, assuming there are 100 Trillium of each age to start with..

$$n(t+1) = An(t)$$

$$\begin{bmatrix} n_0(t+1) \\ n_1(t+1) \\ n_2(t+1) \\ n_3(t+1) \\ n_4(t+1) \\ n_5(t+1) \end{bmatrix} = \begin{bmatrix} \_\_ & \_\_ & \_\_ & \_\_ & \_\_ & \_\_ \\ \_\_ & \_\_ & \_\_ & \_\_ & \_\_ & \_\_ \\ \_\_ & \_\_ & \_\_ & \_\_ & \_\_ & \_\_ \\ \_\_ & \_\_ & \_\_ & \_\_ & \_\_ & \_\_ \\ \_\_ & \_\_ & \_\_ & \_\_ & \_\_ & \_\_ \\ \_\_ & \_\_ & \_\_ & \_\_ & \_\_ & \_\_ \end{bmatrix} \begin{bmatrix} n_0(t) \\ n_1(t) \\ n_2(t) \\ n_3(t) \\ n_4(t) \\ n_5(t) \end{bmatrix}$$

i) Extra credit. Calculate a more precise value for r using the data in the table (NOT adjusted as described in (f)) and the Euler equation. Show your work.