**Spreadsheet Modeling of Exponential and Logistic Growth**

**Introduction:**
Modeling population growth involves repetitive iteration of relatively simple equations; procedures that are well suited to spreadsheet analysis. We will model exponential growth using the equation:

\[
\frac{dN}{dt} = rN \quad [\text{Eq. 1}]
\]

and logistic growth using:

\[
\frac{dN}{dt} = rN(1-(N/K))
\]

**Procedure:**

1. Read the Intro to EXCEL for Bio 146 document.
2. Open a blank EXCEL workbook.
3. Set up a column headed ‘DATA’ (e.g. use column A)
4. Enter last weeks fly egg counts into this column (e.g. into cells A2 through A8)
5. Choose a convenient cell, and enter “MEAN”
6. In an adjacent cell, enter the formula “=AVERAGE(A2:A8)” When you press the <ENTER> key, the arithmetic mean of your data set will appear in this cell.
7. In the same way, set up a cell to calculate the standard deviation (e.g. “=STDEV(A2:A8)”)

Now, set up a new spreadsheet to calculate exponential growth of a population, starting with input values for the net reproductive rate \(R_0\), generation time \(T_{\text{gen}}\), and the initial population size \(N_0\).

Remember, \(r\), the intrinsic rate of increase, is the negative natural log of \(R_0\), divided by the generation time. The Excel formula appears thus:

\[
= -(\ln($D$5))/$E5$
\]

where \(\ln\) is the mathematical function to generate natural logs, \$D5\ is the cell address in which \(R_0\) appears, and \$E5\ is the cell address in which the generation time appears.

Click on the ‘Charts” icon and set up a scatter plot.

Your spreadsheet should look something like this:
Notice that the whole spreadsheet, including the graph, is “active”; if you change any of the input parameters (R₀, T₉₀, or N₀), and hit <ENTER>, the whole spreadsheet and the graph will be updated.

Experiment by increasing and decreasing R₀ and T₉₀. How does the population growth curve respond?

Now, modify your spreadsheet so that your input values are birth rate (b) and death rate (d). Have the spreadsheet calculate R₀ as one half of b-d. (Why one half?).

Estimate b and d for Brown Rats, based on the life history information given in lab #1. Run this data on your spreadsheet. **What would be the population size after 18 months?**

**Print out a copy of your ‘exponential’ spreadsheet and chart for your lab report.**
LOGISTIC GROWTH.

Using your exponential growth model, develop it further to model logistic growth. Obviously, this will require an additional input parameter, the carrying capacity (k). Check the model to make sure the chart shows the expected “s-shaped” logistic growth curve. Now run the model for various combinations of b, d, N₀ and k. How does the shape of the curve vary?

Now rerun the Brown Rat data, using an initial population of 4 and a carrying capacity of 100 animals. How long would it take for the population to stabilize at carrying capacity? Print out your spreadsheet and chart.

THINGS TO CONSIDER

Go to the internet (or library) and locate some basic natural history data (e.g. number of young, gestation period, life span, etc) for a species of interest to you. Use the data to estimate reasonable values for b and d, and choose what seems like a reasonable carrying capacity. Use your spreadsheet to plot the growth of the species to equilibrium.

In what ways is the model unrealistic? What does it not include?