

Bio370L, Life Tables

by Chris Hill

A central goal of population ecology is to understand how populations increase and decrease over time. An important part of the equation is to understand survival rates, (or mortality rates, which are just the flip side of the same coin). There are many ways of gathering or inferring mortality rates. A useful tool once you have gathered data on survival/mortality is the life table, a summary of *age specific mortality rates*.

Here is an example of a life table:

Life Table for Female Wildebeestes in the Ngorongoro Crater, Tanzania*

Age, x, (years)	No. alive at start of age interval, n_x	Proportion surviving at start of age interval, l_x	No. dying within age interval X to X+1, d_x	Finite rate of mortality, q_x	Finite rate of survival, p_x
0	1000	1.00	440	0.44	0.56
1	560	0.56	225	0.40	0.60
2	335	0.34	106	0.32	0.68
3	229	0.23	88	0.38	0.62
4	141	0.14	36	0.26	0.74
5	105	0.11	35	0.33	0.67
6	70	0.07	11	0.16	0.84
7	59	0.06	16	0.27	0.73
8	43	0.04	22	0.51	0.49
9	21	0.02	14	0.67	0.33
10	7	0.01	5	0.71	0.29
11	2	0.00	2	1.00	0.00

*actually, I just made these data up.

Note that the data shown in the five right-hand columns are redundant - each column expresses the same information in a different way. So, given one column, you can calculate all the others.

Focus on the columns for d_x , the number dying within an age interval, q_x , the finite rate of mortality and p_x , the finite rate of survival.

At what age do female wildebeests have the best chance of surviving for another year? _____

In what three-year age bracket do most female wildebeests die? _____

In what three-year period of their lives do female wildebeests have the highest mortality *rate*? _____.

In today's exercise, we will gather the following data from gravestones in a cemetery: year of birth, year of death, and sex. From these data, we can easily calculate the age at which each person died. We can then plug that data into one column of a life table, and calculate the rest of the columns. From the life table, we can examine how human mortality rates vary by age.

Which of the columns in a life table will our data go into? _____

Note: you will have to make sure that the information from each headstone is only collected by one person.

At the cemetery, you will gather data individually, not in teams. Each person will gather data from 40 headstones. Make sure you record the year with four digits (i.e., 1986, not just 86). You do not need to record the month or day of birth or death.

[illegible]

When you get back to the lab, work in groups of 2 to 4.

Create a spreadsheet, enter your data, save to the hard drive send to instructor via e-mail.

Open Microsoft Excel. Create a spreadsheet and enter your data, using the same column headings as on your field data sheet. Create a fourth column, title it "age at death" and enter a formula that will calculate the age at death for each row (remember, all excel formulas start with an equals sign). Please make sure your data's columns are in this order: Sex, Year of Birth, Year of Death, and Age at Death. Save your data to the Ecology folder in My Documents. Give the file a name that includes all the initials of the contributors, like "HGG BAJ SLT data"

You also need to send your data to your instructor so I can collate data from the entire class. Once you have saved your dataset to the computer, send the Excel file containing your data to me via email: jjhutch@coastal.edu.

Create a Life Table

Return to Excel, and open a new blank worksheet. Click on the number "1" at the far left of the first row to select the entire row. Then from the Format menu, select "Cells..." and click on the "Alignment" tab. Check the "wrap text" box, and for text alignment select center for both horizontal and vertical. Click OK to close the dialog box. Type column headings into row 1 of your worksheet, using the Wildebeest life table as a model. For the Age column, fill in "0" in row 2, "1" in row 3, then highlight those two cells, click on the lower right corner and drag down to fill in ages up to 100 (or the greatest age attained by anyone in your sample).

Enter your data into the life table

Return to the data you collected today, and sort your data by "age at death:" [Highlight your entire data table, column headings included. From the "Data" menu, choose "Sort..." Make sure that "my list has header row" is selected, then sort by age at death.]

You are now ready to transfer your data to the life table. The number of people that died at each age in your sample can be filled in to the fourth column in your life table, "No. dying within age interval X to X+1: d_x ." If there is nobody in your sample who died in their first year of life, put a zero for d_x in the row for age zero. If two people died at age one, put a "2" for d_x in the row for age one. Continue until all your data is entered.

Filling out the rest of the life table

You will be entering the grand total number of individuals in the data set (i.e., how many headstones were read) into the n_x column for age zero. You will be entering formulas into all the other cells. **Note that the Excel versions of the mathematical formulas in the table below are on the next page.** The columns are related as follows.

Age, x , (years)	No. alive at start of age interval, n_x	Proportion surviving at start of age interval, l_x	No. dying within age interval X to X+1, d_x	Finite rate of mortality, q_x	Finite rate of survival, p_x
0	[Total # individuals in your data set]	$\frac{n_x(\text{at this age})}{n_x(\text{age zero})}$	from your data	d_x/n_x	$1-q_x$
1	$n(\text{age } x-1)$ minus $d(x-1)$	$\frac{n_x(\text{at this age})}{n_x(\text{age zero})}$	from your data	d_x/n_x	$1-q_x$

Useful Excel tip: normally when you drag and fill formulas, the cell references that get copied are *relative* cell references - if cell C1 has the formula $=A1+B1$, and you copy the formula into cell C2, what gets entered into C2 is not $=A1+B1$, but $=A2+B2$. In essence, when you enter $=A1$ into cell C1, Excel interprets that A1 as "the cell two columns left of the present cell." You can make Excel use *absolute* cell references by preceding a reference by a dollar sign. If you enter this formula into cell C1: $=\$A\$1+B1$, and then drag or copy that formula elsewhere, it will always refer back to cell A1.

If you have created your worksheet the same way I did, the formulas below should work. At the very least, they may give you an idea how to proceed.

Disclaimer: These formulas are provided as a convenience to you, as not everyone has comparable experience with Microsoft Excel. They are not guaranteed to work for you. You are responsible for making sure your method of getting the answer works, and for checking your own answers.

Age, x, (years)	No. alive at start of age interval, n_x	Proportion surviving at start of age interval, l_x	No. dying within age interval X to X+1, d_x	Finite rate of mortality, q_x	Finite rate of survival, p_x
0	data	=b2/b\$2	data	=d2/b2	=1-e2
1	=b2-d2	=b3/b\$2	data	=d3/b3	=1-e3
2	=b3-d3	=b4/b\$2	data	=d4/b4	=1-e4
etc.	etc.	etc.	etc.	etc.	etc.

Assignment:

This is one of your two individual lab write-ups for the semester. It's worth 5 more points than a group lab, and the rules are slightly different--you must analyze the data, present the results, and write the text of your report by yourself.

The printed lab report is due by 5 PM Friday of next week. I will put a composite dataset, in Excel format, on the Ecology lab web page representing the lab's data soon after lab. Go to the ecology class web page at: <http://ww2.coastal.edu/jjhutche/bio370L.htm>. Then click on the link to the dataset.

Your jobs are

- 1) To construct two life tables (one each for males and females, separately) using all the data gathered by your lab.
- 2) To graph age vs. the age-specific mortality rates (q_x) for males and for females.
- 3) To calculate and report some summary statistics (e.g., mean, median, max, n, etc.,) of the Age at Death data (do NOT calculate summary statistics for the q_x data) for males and for females.
- 4) To compare and contrast the patterns you observed for males and for females (i.e., compare the two mortality curves and the summary statistics). However, you do **not** need to do any t-tests or ANOVA to compare the two sexes.
- 5) To write the whole thing up in the standard form (i.e., intro, methods, results, discussion). Make sure you discuss your reasons for **why** the patterns you observed occur.
- 6) To make sure you provide the graph(s), **both** life tables, as well as the text on time (you lose a letter grade for each school day it's late).