FUNDAMENTALS OF ECOLOGY: LIFE TABLES

The study of demography and population dynamics is one of the most basic components of population ecology. This week's lab will enable you to collect, enter, and analyze a set of demographic data collected from a series of cemeteries in the Green Bay, Wisconsin, USA area. You will use these to help answer hypotheses regarding the effect of gender, death date, and physical location on cohort survivorship curves and life expectancy.

Background

The summary of demographic data through life tables and survivorship curves is a basic methodology in population ecology. Survivorship curves graphically represent the numbers of survivors of a given cohort of individuals over time, so that time-specific mortality rates can be easily compared. Life tables are used to analyze cohorts of individuals in a way in which a number of age-specific population parameters can be calculated. As survivorship curves are rather easy to construct, let us consider in depth the more complicated life table. The study of populations through life tables requires the memorization of a few mathematical variables and formulas which are essential in their construction:

x = the age interval used in the life table

n_x = the number of survivors at the start of age interval x

l_x = proportion of organisms in the cohort (or population) surviving to the start of age interval x. This can be represented by the following formula:

$$l_x = n_x/n_o$$

where:

n_o = the total number of individuals at the start of the first age interval

d_x = number dying during the age interval x to $x+1$

q_x = rate of mortality in the cohort (or population) during the age interval x to $x+1$. This can be represented by the following formula:

$$q_x = d_x/n_x$$

e_x = the mean expectation of life (measured in age intervals) for organisms at start of age x

While the calculations for the first five of these variables are easy, those for e_x (expectation of further life) are more complicated, requiring the determination of two additional variables, L_x (which is the average number of individuals alive during the age interval x to $x+1$) and T_x (the total number of age intervals to be lived by surviving members of the cohort from age interval x on). These two variables are expressed as follows:

$$L_x = \frac{n_x + n_{x+1}}{2}$$

$$T_x = \sum L_x$$

From T_x, e_x can be calculated from the following equation:

$$e_x = T_x / n_x$$

While this may look complicated, it really isn't. As Krebs has stated in his *Ecology* textbook, "This whole procedure, like most mathematical exercises in ecology, looks much more formidable than it really is." The main thing to remember is that you are being given the date of birth and death for each person. From that you can calculate how old they were when they died by subtracting the year of birth from the year of death. (yes, this is approximate only because we did not write down their day of birth and death!)

IF WE ASSUME THAT THIS REPRESENTS A CROSS-SECTIONAL SAMPLE OF THE POPULATION AT A GIVEN MOMENT IN TIME (which if course it isn't, but that's not important here as we are just practicing making life tables), then determining how many people died between ages 0-9 gives us d_0; the number that died between ages 10-19 gives us d_1 and etcetera. Once you have all d_x values in a given table, you can sum them to determine n_o and once you know that then its easy to calculate n_x by the formula $n_{x+1} = n_x - d_x$. After doing this you can just fill in the table using the above formulas.

The data file found in the course materials in IS (GRAVE.DBF) has four data fields: date of birth, date of death, gender (male or female), and location (urban or rural cemetery). Your job is to use your spreadsheet / database skills to sort the data to determine d_x for six different comparisons: male vs. female; died before 1950 or after; urban vs. rural cemeteries. And then from that to fill in the rest of the life tables.

LIFE TABLE WORKSHEET - ALL MALES

x	n_x	l_x	d_x	q_x	L_x	T_x	e_x
0							
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

LIFE TABLE WORKSHEET - ALL FEMALES

x	n_x	l_x	d_x	q_x	L_x	T_x	e_x
0							
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

LIFE TABLE WORKSHEET – DIED BEFORE 1950

x	n_x	l_x	d_x	q_x	L_x	T_x	e_x
0							
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

LIFE TABLE WORKSHEET – DIED AFTER 1949

x	n_x	l_x	d_x	q_x	L_x	T_x	e_x
0							
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

LIFE TABLE WORKSHEET - URBAN

x	n_x	l_x	d_x	q_x	L_x	T_x	e_x
0							
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

LIFE TABLE WORKSHEET - RURAL

x	n_x	l_x	d_x	q_x	L_x	T_x	e_x
0							
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							