Construction of Life Tables

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Both ecologists and actuaries employed by insurance companies are interested in death rates. Simply knowing the number of deaths in a population per year, month or day is however not sufficiently informative. Both ecologists and actuaries need age specific death rates, although for quite different reasons. They need to answer questions such as, "Is infant (or seedling) mortality higher than mortality later in life?" "What is the life expectancy of an individual at any given age?" The mortality schedule used to answer these questions in called a **Life Table**.

The best approach for collecting raw data for a life table is quite straightforward: follow a group of individuals in the same population from birth to last death in the group. A cohort is a group of individuals born (or germinating) in the same defined interval. A **cohort** of humans usually consists of individuals born in the same calendar year, but of course much smaller intervals (i.e., those born the same month, week, or day) need to be prescribed for short-lived organisms. A life table compiled in this manner is called a **cohort (or age-specific) life table**.

Compiling data for a cohort life table is difficult for long-live organisms such as humans simply because the study would take a whole life time! Alternatively, researchers tally the deaths within each age group in the population over a prescribed time interval (e.g., all the deaths in each age class in a town in one year). Life tables tabulated in this manner are called **static (or time specific)** life tables because we must assume that (1) age specific mortality rates did not change over time (i.e., between generations) and (2) the population size did not change so there is a stable age distribution. That is, the population is static. Neither assumption may be justified. For instance, in this procedure individuals share only a common time in which they died; they were born (or germinated) at different times an thus may have experienced different environments at a certain age (e.g., as juveniles). It is up to the investigator to determine whether these assumptions are reasonable and thus whether a static life table design will produce reasonable estimates of survival.

In this exercise we will collect data for both types of life tables.

Constructing a Cohort Life Table

We will use data from a cohort life table for *Phlox drummondii*, an annual flowering plant, to work through a life table as a class.

Age class in days, $x - x'$	Number surviving to x, d_x	Proportion surviving to x, l_x	Proportion dying in interval, d_x	Mortality rate, q_x
0–63	996	1		
63-124	668			
124-184	295			
184-215	190			
215-264	176			
264-278	172			
278-292	167			
292-306	159			
306-320	154			
320-334	147			
334-348	105			
348-362	22			
362-	0		—	—

The variables used in the life table construction are as follows:

n_x = the *number* of individuals in a population (or cohort) of age class x.
l_x = the *proportion* of a population (or cohort) alive at the start of age class x. Estimates the chance of an individual surviving to age x.

$$l_x = \frac{n_x}{n_0}$$

d_x = the proportion of all deaths that occur within age interval x. This will sum to one.

$$d_x = l_x - l_{x+1}$$

q_x = mortality rate. The probability of dying during *during* the age interval x to $x+1$, given that the individual has already survived to the start of the interval.

$$q_x = \frac{d_x}{l_x} = 1 - \frac{l_{x+1}}{l_x}$$

Follow along with the teaching assistant to fill out this table. Then plot l_x and d_x against age to obtain survival and mortality curves using the graph paper provided. Then plot l_x against age using the *semi-log* graph paper provided. Make sure you understand what each graph is showing.

Constructing a Static Life Table

You will then construct a static life table using data from the Beckett Street Cemetery, in Leeds, United Kingdom. This cemetery was opened in 1845 and was among the first public cemeteries in Europe. They also kept terrific records of who was buried, so it, and other cemeteries, are a good source of data on survival and mortality through time. The data on the number buried are as follows:

Year	1851	1891	1931
Total buried	1678	3317	595
$<$ 1 year	482	892	71
1–4	400	599	27
5–14	122	135	9
15-29	175	231	25
30–49	204	458	58
50-69	195	685	194
$>$ 70	100	317	211

You need to calculate and graph l_x and d_x against age for each of the three years. Consider these three representative periods of human survival in England during which time a great many aspects of life changed. I would encourage you to graph these by hand, but you are welcome to use a spreadsheet if you prefer.

Homework

There is no homework assignment for this lab, but you need to have the TA check your work before you leave. Also, this lab will be the subject of a quiz next week, so please get your questions sorted out during lab!