Human Life Table

Introduction.
Life tables are used to describe and understand the population dynamics of a species. This information is important in conservation studies (reintroduction of species), agriculture (reduction of pest species), and human health (following epidemics). Using reintroduction of a species as an example, life tables can indicate when a breeding population has been established.

There are two types of life tables, based on the method of data collection. **Age-specific** life tables are based on the fate of a real **cohort** (group of individuals). Group members belong to the same generation and the population may be either stable or fluctuating. Age specific life tables are also known as **horizontal** or **cohort** life tables.

Time-specific life tables are based on an imaginary cohort. Researchers collect data and determine age structure at a point in time. The population is assumed to be stationary. Time-specific life tables are also known as **vertical** or **static** life tables.

Calculations.
Below is an example life table for the barnacle, *Balanus glandula.* Unlike most animals, barnacles are sessile as adults (they remain plastered down in a single place and do not move). This makes them easy to follow over long periods of time. During the first year researchers mapped out the distribution of 142 animals on a rocky coastline. They then return to the site for nine years and determined which individuals died (any missing from the map were known dead since barnacles cannot move as adults. Their data are shown below.

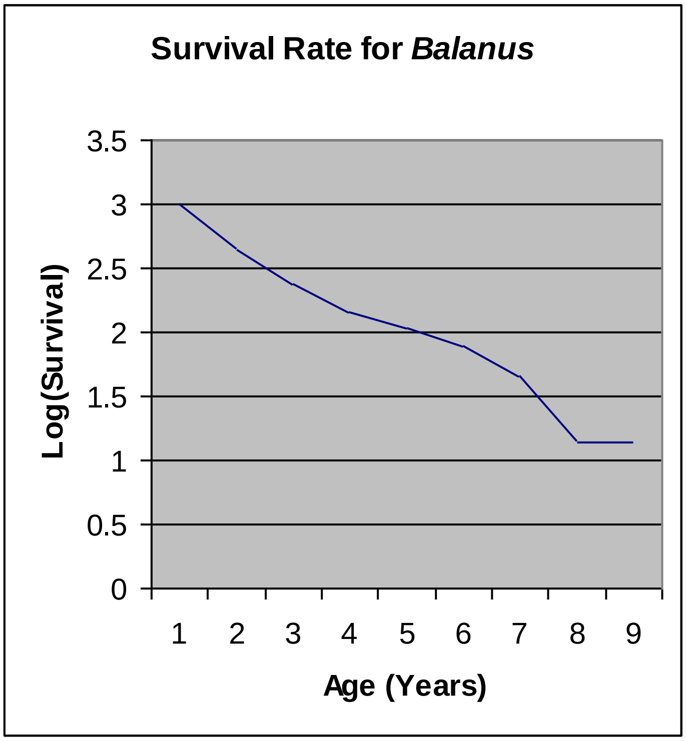
Life Table for the Barnacle *Balanus glandula*

Age (yr) *x*	Obs # Alive n*x*	# Surviving l*x*	# Dying d*x*	Mort. Rate q*x*	Avg # Alive L*x*	T*x*	Life Expec ex	For Graph log(lx)
0	142	1000	563	0.563	718.5	1577	1.577	3
1	62	437	198	0.4530892	338	858.5	1.9645309	2.640481
2	34	239	98	0.4100418	190	520.5	2.1778243	2.378398
3	20	141	32	0.2269504	125	330.5	2.3439716	2.149219
4	15.5	109	32	0.293578	93	205.5	1.8853211	2.037426
5	11	77	31	0.4025974	61.5	112.5	1.461039	1.886491
6	6.5	46	32	0.6956522	30	51	1.1086957	1.662758
7	2	14	0	0	14	21	1.5	1.146128
8	2	14	14	1	7	7	0.5	1.146128
9	0	0	--	--	--		--	--

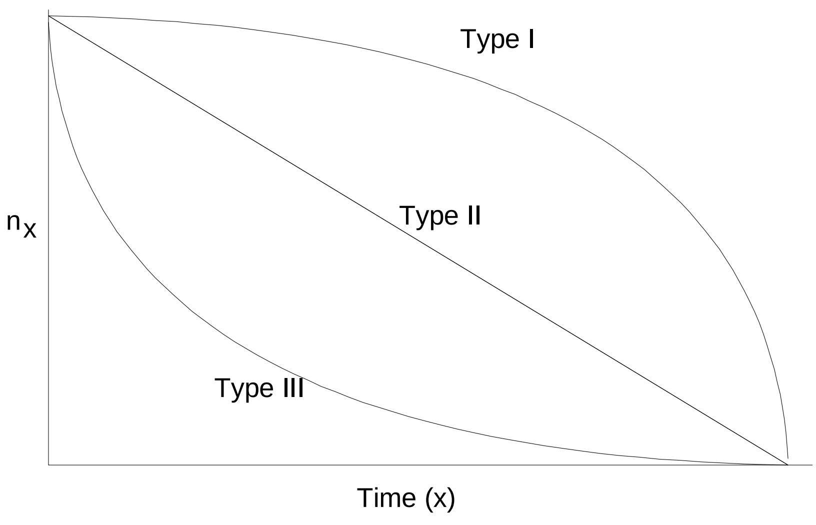
- The first column (***x***) is the age of the animals in years. Depending on the beast, this may change. Mice, for example, may be better followed on a monthly basis, while long-lived animals (such as ourselves, crocodiles, and turtles) may be better followed in five-year intervals.
- The observed number of alive (n_x) is the actual number of barnacles counted each year (*x*). The researchers used half-counts during years 4 and 6 since they determined that the animals recently died (within the past week). They could determine this since there were "scars" still visible at the map positions of the individuals.
- The third column (l_x) is the number of surviving individuals adjusted to a standard population size of 1000. The value at 1 year is calculated as the current n_x divided by the original population size, then multiplied by 1000. For example, year 1 is (62/142)*1000 while year 2 is (34/142)*1000. The values are rounded to the nearest whole number.
- The number dying (d_x) represents the change in population size from year *x* to year *x+1*. The number dying during year 0 is 1000-437=563. For year 1 the number dying is 437-239=198.
- The mortality rate (q_x) is calculated by dividing the current year's d_x by the current year's l_x. For year 0, 563/1000=0.563. For year 1 the mortality rate is 198/437=.453.
- The average number alive during any particular year (L_x; don't confuse with the number surviving) is calculated by adding together $l_x + l_{x+1}$ and dividing by 2. Thus, for year 0 the average number alive is (1000+437)/2=718.5! For year 1: (437+239)/2=338.
- The seventh col column (T_x) is an intermediate value for calculating the life expectancy. It is calculated by cumulatively adding the L_x values from the <u>bottom up</u>. Thus, for year 8, $T_8= L_8+L_9$ (T_8=0+7=7). For year 7, , $T_7= L_7+L_8$ (T_8=14+7=21).
- The life expectancy (e_x) is the average life expectancy of barnacles of age x in barnacle-years. It is calculated by dividing T_x by l_x. For year 0, the average barnacle is expected to live for only another 1.577 years (1577/1000). If they

survive the first year, their life expectancy is an additional 1.9 years (858.5/437). Note that once the animals get past the first few years, the ones that survive get to live for a longer time.

- The last column is used to calculate a **survivorship curve**. It is simply the log of the number surviving ($\log(l_x)$). The graph for the above data follows:



There are three possible types of survivorship curves:



A type **I** survivorship curve is characterized by having most of the mortality among the older individuals. A type **II** curve has a constant rate of mortality, while a type **III** curve has most of the mortality among the young. Humans in developed nations have a type **I** curve. Most birds are type **II**. Fish, insects, many marine invertebrates, and parasites are characterized by a type **III** curve.

A live calculation worksheet can for the *Balanus* population can be found here: http://cas.bellarmine.edu/tietjen/Balanus%20LifeTable.xls. A further discussion on life tables can be found here: http://www.gypsymoth.ento.vt.edu/~sharov/PopEcol/lec6/lifetab.html.

Human Life Table Assignment.
Work in groups of two. For this exercise you will create human life tables using both historical and current data. Current data is collected from the obituary section of the Louisville Courier Journal. You can find back issues of the Courier at the library. As you collect your data (working backwards through the obituaries), record the age and sex of the person that died. You will need 100 males and 100 females for your study. If you cannot tell the gender of the person from their name, skip them. Group your data into five-year age categories (0-4yr, 5-9yr, etc.). For each age category you will have a count of the number of people that died.

Now for the fun part! Historical data is collected from a local cemetery that dates back at least 100 years (such as the Cave Hill Cemetery). Remember to check the closing time for the cemetery; we've had students locked in several years ago (before they put the razor wire up on the fence. Starting in 1900, collect age at death and gender data for 100 males and 100 females as before. Group your data into five-year age categories.

Calculations.
An Excel-based worksheet for the human life table assignment can be found here: http://cas.bellarmine.edu/tietjen/Human%20LifeTable.xls. Enter your data in either the second **or** the third column. The spreadsheet will calculate the life table for you. Enter separate data for recent males and females and historical deaths separated by sex (you'll have 4 spreadsheets). Print out your results. You can save your spreadsheets to your local drive or to a floppy disk. You can not save to the server.

Report.
1. Compare and contrast the survival curves and life table data between males and females. Do this for both the historical data and recent deaths. Are the any differences either historically or recently between the sexes?
2. Compare survivorship curves and life table data for recent male deaths as compared to historical deaths of males. Do the same for females.
3. Did you notice a "blip" in the historical data for 1918-1919? What caused this "blip" (a clue is found here: http://pharmacology.miningco.com/library/weekly/bl980929.htm?pid=2789&cob=home).
4. What type of survivorship curve is seen for the human data? Under what conditions would you expect to see a type I or type II curve for a human population? What type of survivorship is shown in the barnacle?
5. Discuss the concept of Demographic Transition as related to your data.