Recitation Section 21 Answer Key
April 27-28, 2005

Life Tables

A. Cohort life table

You are studying the life of the common tribble. In a large tribble colony, you mark 1000 newborn tribbles and observe them for the next 5 years. You find the following:

1. Derive formulas for and calculate the remaining values in the table, based on the following definitions.

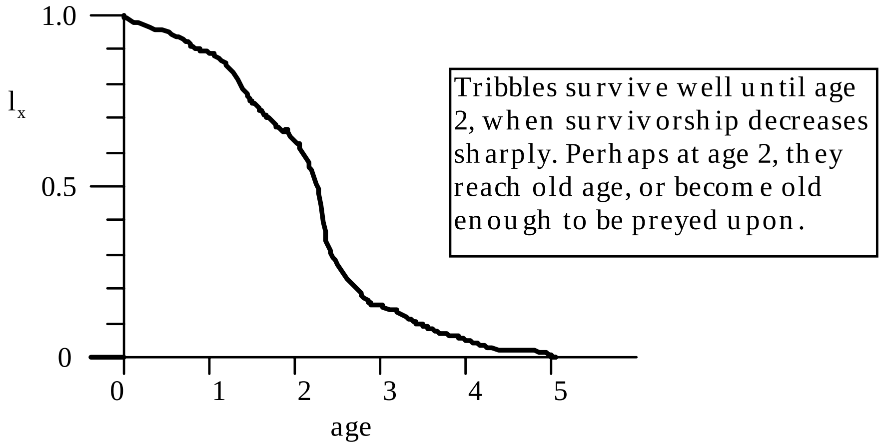
l_x survivorship in year x = survival of individuals to age x
m_x mortality rate in year x = proportion of individuals of age x dying by age x+1
L_x age units lived in year x = mean # of individuals alive between year x and x+1
e_x remaining life expectancy at age x = expectation of further life for individuals of age x

$$e_x = \frac{\sum_{i=x}^{5} L_i}{n_x}$$

$s_x = \frac{n_{(x+1)}}{n_x}$ $l_x = \frac{n_x}{n_0}$ $m_x = 1 - s_x$ $L_x = \frac{n_x + n_{(x+1)}}{2}$ avg. life expectancy $= x + e_x$

Year (age) x	**# tribbles alive at start of year n_x**	**Survivor-ship l_x**	**Mortality rate m_x**	**Mean # tribbles alive in year L_x**	**Average Remaining Life Expectancy e_x**	**Average life expectancy for individuals of age x**
0	1000	1	0.1	950	2.35	2.35
1	900	0.9	0.22	800	1.55	2.55
2	700	0.7	0.71	450	0.86	2.86
3	200	0.2	0.75	125	0.75	3.75
4	50	0.05	1.00	25	0.50	4.50
5	0	0			0.00	

2. Sketch the survivorship curve for tribbles:
3. Describe this curve in words. Speculate on what could cause the qualitative shape of the curve.



4. What other types of curves are there? Describe qualitative conditions that produce these curves.

The immediate exponential decay curve applies to organisms that have a lot of offspring that die very young, such as frogs, fish, or trees.
The linear decay curve applies to organisms whose probability of dying is not dependent on age.
The very slow decay followed by the exponential decay curve applies to organisms that have very few offspring, and take great care to protect those offspring, such as humans.

B. Replacement rates

You also collected data on the tribbles born to the cohort you are studying. This is summarized below:

YEAR (age) x	**# tribbles alive at start of year nx**	**# individuals born to members of cohort during year x**	**Fecundity bx**	**lxbx**	**for question 3**	**for question 4**
0	1000	0	0	0	0	0
1	900	1200	1.33	1.2	0	0
2	700	100	0.14	0.10	2	0
3	200	50	0.25	0.05	0	4
4	50	5	0.10	0.01*	0	0
5	0	0	0	0	0	0

1. Calculate the fecundity and realized fecundity ($l_x b_x$) for each age group.
2. Calculate the net reproductive rate, $R_0 = \sum_{i=0}^{i=5} l_i b_i$. Is this population stable (R_0=1), growing (R_0>1), or shrinking (R_0<1)?

R_0 = 1.20 + 0.10 + 0.05 + 0.01 = 1.36 therefore: growing

3. Suppose you find tribbles with the same life expectancies except that they all give birth to 2 new tribbles only once in their lifetime, at an age of 2 years. Will the resulting population be stable?

Only one term: R_0 = 1.4 therefore: growing

4. Suppose you find tribbles with the same life expectancies except that they all give birth to 4 new tribbles only once in their lifetime, at an age of 3 years. Will the resulting population be stable?

Only one term: R_0 = 0.8 therefore: shrinking. These tribbles don't reach reproductive age until after they've started to die of old age.