

Life tables and survivorship types

Learning Objectives:

Step 1

Part I: Life table

Part II: Survivorship curves

Week 7: Life Tables and Matrix Modeling

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Nate Wehr and Elie Gurarie (modified from Owen R Jones)

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This lab was originally developed by Prof. Owen Jones (<https://www.transmittingscience.com/instructors/owen-r-jones/>) as part of a course similar to ours (https://jonesor.github.io/BB512_Book/) taught at Odense University in Denmark.

Life tables and survivorship types

Life tables are tables that show the probability that an individual of a given age class will die before their next birthday (*probability of death*). This exercise deals with **cohort life tables**, which follow a “*cohort*” from when they’re all born until they all die. A cohort is the group of individuals born within a particular time interval (e.g., “*all individuals born in 1998*”).

Life tables are used extensively in population biology, human demography, and epidemiology. They are also important outside of biology (e.g., management of product life-cycles, such as in cars or other machinery).

Learning Objectives:

1. Increased competence in using Excel formulae for biological modeling

2. Understanding how life tables are calculated

3. Understanding the three types of survivorship curves

Step 1

Download and open the “Life Tables” Excel file from the Recitations folder on Blackboard.

The file has two tabs “Life Table” and “Survivorship Curves”.

Part I: Life table



Let's start with “**Life Table**”.

The aim is to use Excel as a modeling tool to produce a life table. We have provided some initial data collected from a cohort of impala ewes (*Aepyceros melampus*; photo credit to Nate). We know how many individuals survived each year (S_x). We also know how many babies were produced by the cohort each year (B_x). We can therefore use this information to calculate the growth rate of the impala population we're studying.

Start by calculating survivorship (l_x). Survivorship is the **probability of survival to a particular age**. Therefore, at time 1, $l_1 = 1$, since everyone is alive at this point. The next value (l_2) must be calculated based on the number alive at that point. In algebraic form, the equation is $l_x = S_x/S_0$. So, for l_2 , you would do $352/500 = 0.704$. Generalize this calculation into a formula that can be dragged to fill column “D” in the worksheet.

Next, you can calculate age specific **survival probability**. Note that this is different from l_x . Survival probability is simply the probability that an individual will survive its current age class. The calculation is $g_x = l_{x+1}/l_x$, or S_{x+1}/S_x . For example, $g_2 = 298/352 = 0.85$. This is the probability that an individual currently age 2 will survive to become age 3. Generalize this calculation into a formula that can be dragged to fill column “E” in the worksheet.

We will next calculate the mean number of offspring produced by each female (b_x). We can calculate this for each age class by dividing the number of offspring produced (B_x) by the number of females alive (S_x). So, $b_6 = 189/172 = 1.10$. Generalize this calculation into a formula that can be dragged to fill column “F” in

the worksheet.

Next, we will calculate **reproductive rate** (R_x) using $R_x = l_x * b_x$. Generalize this calculation into a formula that can be dragged to fill column "G" in the worksheet.

The last column is our **generation time** (G_x). Generation time can be calculated as $G_x = x * R_x$. Generalize this calculation into a formula that can be dragged to fill column "H" in the worksheet.

Finally, we can get to the important parts! Below our life tables, we have spots for R_0 , G , and r . The important one we want to get to is r , but first we have to calculate R_0 and G . To calculate the reproductive rate, we use the equation $R_0 = \sum R_x$. This can be done in excel using the sum function `=sum()`. Generation time similarly uses the equation $G = \sum G_x$, so this also uses the sum function `=sum()`. We can then calculate r using the equation $r = \log(R_0)/G$. In Excel, the log function is `=log()`.

Once you calculate r , your table is complete. Take a screenshot of the table and save it to a word document. On the lab computers, this can be done using the Snipping Tool, which is accessed by using the search bar in the bottom left corner of your screen.

On the same word document: in a few sentences explain what the r -value you received means about this population of impala, and how we might use this information to manage them.

Part II: Survivorship curves

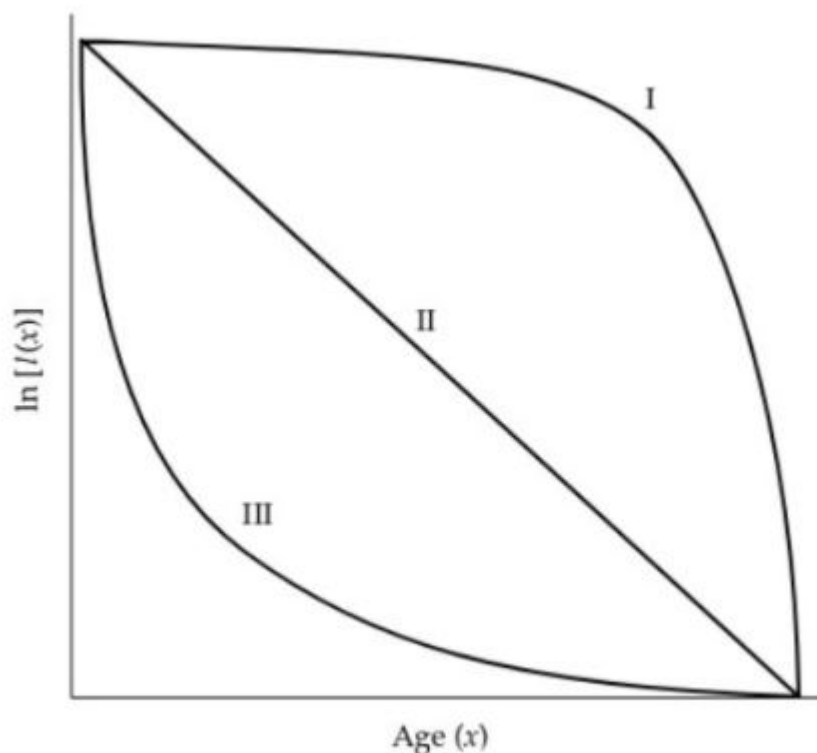


Figure 3.2 Type I, II, and III survivorship curves. Note the logarithmic transformation of the y axis.

For the second part we will use the **Survivorship Curves** worksheet.

Our goal is to explore how different types of organisms with different **life history strategies** can have qualitatively different kinds of life tables. The most important thing to observe is the difference in **survivorship curves** (l_x). These changes become very obvious when you plot the log-transformed survivorship against age.

In the Excel worksheet, we have placed tables showing the fate of cohorts of three populations of different species. Your job now is to calculate the survivorship curve (l_x) for these species. Remember that $l_x = S_x/S_0$. Then, you can use the `=log()` function to log transform survivorship.

As you fill in these three simplified life tables, you should see that the graphs automatically fill up with lines. Once you have filled out the life tables and created the three graphs. Take a screenshot and copy them into your Word Document.

Below the picture of your graphs answer these questions: 1) What type of survivorship curve does each population follow? 2) Population 1 uses the impala data from Part I; What species might have been followed for Population 2 and Population 3, respectively?