Biology 3103 - Ecology Laboratory

S Cook

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Contents

Chapter 1

Population Ecology

1.1 Exploration of life history strategies with population demography

Organisms have evolved different life history strategies which differ in their methods of reproduction, care of offspring, timing of growth, means of resource acquisition, and prey avoidance. While these factors and how they interact can be highly complex, **survivorship** offers a simple means to quantify how a particular population ensures their reproductive success. For example, humans devote an enormous amount of energy and resources to offspring care, which results in low mortality rates among their young. On the other hand, most insects produce a massive number of offspring that have extremely high rates of mortality.

Plotting the number of survivors against age yields what is called a 'survivorship-curve' (Fig. 1.1), which is a visual way to assess how various organisms differ in their **life-history strategies** (number of offspring, number of reproductive cycles, degree of parental care, etc.). Scientists can use these plots to examine differences in organisms, or assess changes within subsets of a population.

1.2 Objectives

You will use the cemetery data, as well as data generated by the U.S. Fish & Wildlife Service (Milsap et al., 2016), to address hypotheses about different populations. We can use birth and death years on gravestones, as well as names (to infer gender), to collect simple but useful information to collect demographic data for the local human population. The survivorship curve you will generate from this data will inform some ideas about the life history strategy of humans.

Additionally, survey data collected by state and federal agencies provide valuable information about natural population. We can use ancillary data about individuals within a population to examine how different forces influence demographics within a population. Golden Eagles are federally protected in the United States, and Fish & Wildlife collects detailed information from tagged individuals (Fig. 1.2).

We will use this data to test hypotheses addressing the following questions:

1. Do humans and eagles display different life history strategies?
2. Does gender affect survivorship in human populations?
    - And if so, how?
3. Does human impact affect survivorship in eagle populations?
    - And if so, how?

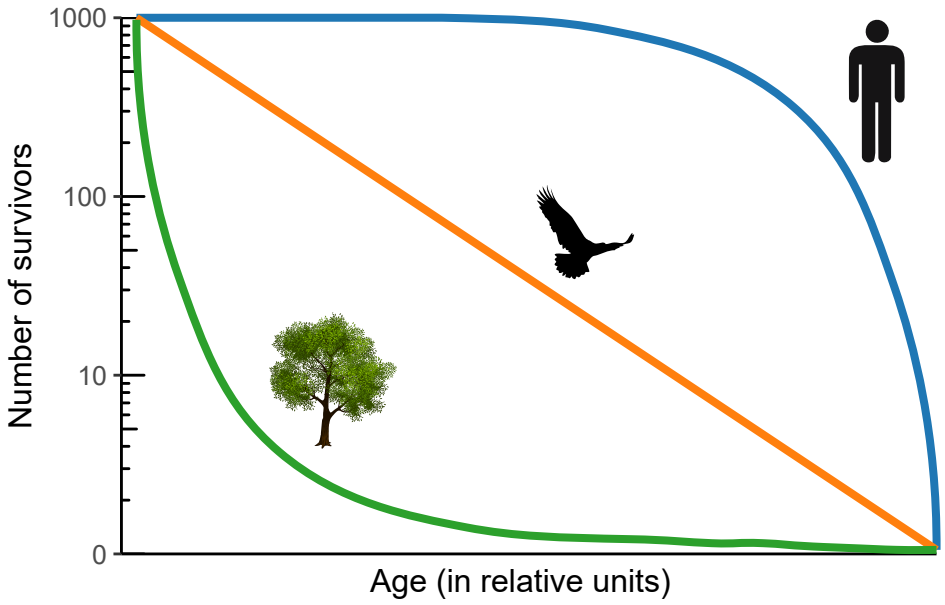

Figure 1.1: Idealized examples of Types I, II, and III survivorship curves overlaid with example organisms. Type I survivorship is characterized by high probability of survival early in life, followed by a rapid decline as individuals reach older age. Type II survivorship displays roughly constant mortality throughout the lifespan of the organism, and Type III exhibits high mortality among young offspring.

Figure 1.2: Migratory Golden eagle in Denali National Park & Preserve. Mating pairs return each year to northern nesting territory in the spring, and most new fledglings leave the nest by mid-August. During winter their range extends from southern Canada to south of the Rocky Mountains (Brown et al., 2017).

Please form testable null hypotheses to address question number 1 and **either** question 2 or 3 (pick one). If you want, you may also substitute question 2 or 3 to address a hypothesis using the extra data we generated from the gravestones (height of gravestones as a proxy of material wealth).

To evaluate your hypotheses, you will…

1. Statistically address differences in survivorship between groups using a **t-test**, and display that information using a **bar-graph**
2. Unpack question 1 by **computing** and **displaying survivorship** (no statistical test needed for this part).

1.3 Data Analysis

1. Calculate the age at death of every individuals in both data sets
2. If necessary, use Excel to sort (Google it) the data based on your column of interest (i.e. gender).
   - Sorting the data easily splits the population into groups that you can then run the calculations (below) on. If you are doing the entire population, you will not need to split the population, but for within-population questions this step will come in handy. Keep in mind that every time you split the data based on a categorical variable, you will normalize to a hypothetical population of 1000 for the survivorship plots below.
3. Calculate mean age at death, as well as a measure of variation around that mean for use in the **bar-graphs**.
   - The **bar-graph** is just a visual representation of the data. You will perform a **t-test** on this data and report the results to determine if the population means are actually different.
4. Create a survivorship table
   - Create "bins" of individuals
     - 0 to 1, 1 to 2, 2 to 3, etc… for Golden Eagles
     - 0-9, 10-19, 20-29, etc… for humans
   - Calculate the number of individuals surviving to that age class (the 'countif' function in Excel will come in handy here). Keep in mind that for the first group you will want to count **all** of the observations in the data set, so your condition will be '>=0'.
   - Normalize survivors to a hypothetical population of 1000
     - This will make comparisons possible between unequal sample – so if you have 1250 observations in the data set, your normalized number for the first age class will be 1250/1250 = 1.0, which is a proportion you can multiply by 1000. For the second age class (if you have some mortality), it might be 975/1250 = 0.78, which you can then multiply by 1000 which equals 780.
5. Plot the number of survivors (y-axis values) against age class (x-axis values) to construct the survivorship curves. You may plot the data from the survivorship table either as normalized survivors, or on a logarithmic x-axis (typically how this data is displayed, as in Fig. 1.1).

The procedure above will ultimately yield survivorship (number of surviving individuals at a particular age class), which you may plot to visually explore differences between groups of interest to you.

1.4 Lab Report Specifics

Below are some specific guidelines for this lab report, but you should also utilize the general grading rubric in the Syllabus!

- **Participation** (1 pts)
- **Introduction** (3 pts)
  - General information about population ecology / life history strategies

  - How are survivorship curves used in population ecology?
  - Build up rationale to lead into your objectives/hypotheses statements.

- **Methods** (3 pts)
  - Explanation of data collection and analysis

- **Results** (6 pts)
  - Summary statistics in the text
  - Bar-plots and associated t-tests for each question
  - Survivorship curves for each question

- **Discussion** (3 pts)
  - Explain your results in light of your hypotheses
  - What are some plausible explanations for differences (or lack thereof) between groups?
  - Place your results in an evolutionary context.

Bibliography

Brown, J. L., Bedrosian, B., Bell, D. A., Braham, M. A., Cooper, J., Crandall, R. H., DiDonato, J., Domenech, R., Duerr, A. E., Katzner, T. E., Lanzone, M. J., LaPlante, D. W., McIntyre, C. L., Miller, T. A., Murphy, R. K., Shreading, A., Slater, S. J., Smith, J. P., Smith, B. W., Watson, J. W., and Woodbridge, B. (2017). Patterns of Spatial Distribution of Golden Eagles Across North America: How Do They Fit into Existing Landscape-scale Mapping Systems? *Journal of Raptor Research*, 51(3):197–215.

Milsap, B. A., Bjerre, E. R., Otto, M. C., Zimmerman, G. S., and Zimpfer, N. L. (2016). Bald and Golden Eagles: Population demographics and estimation of sustainable take in the United States, 2016 update. Technical report, U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Washington D.C., USA.