S Cook

Biology 3103 - Ecology Laboratory

”Shouldn’t you be working on your dissertation?” - Katherine Hooker

Contents

List of Tables **v**

List of Figures **vii**

Preface **ix**

1 Population Ecology **1**
- 1.1 Background information 1
- 1.2 Objectives 1
- 1.3 Data Analysis 3
- 1.4 Lab Report Specifics 5

2 Physiological Ecology **7**
- 2.1 Background information 7
- 2.2 Objectives 8
- 2.3 Materials & methods 8

Bibliography **9**

Index **11**

List of Tables

List of Figures

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. 2
1.2 Migratory Golden eagle in Denali National Park and 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). 3

2.1 Aquatic algae (left pane, both underwater and floating mats) and aquatic macrophytes (right pane) are photosynthetic organisms that evolved in aquatic ecosystems. 8

Preface

Filler.

Why read this book

More filler.

Structure of the book

Chapters **??** introduces a new topic, and …

Software information and conventions

I used the **knitr** package (Xie, 2015) and the **bookdown** package (Xie, 2018) to compile my book. My R session information is shown below:

```
sessionInfo()
```

```
## R version 3.4.4 (2018-03-15)
## Platform: x86_64-w64-mingw32/x64 (64-bit)
## Running under: Windows 10 x64 (build 17134)
##
## Matrix products: default
##
## locale:
```

```
## [1] LC_COLLATE=English_United States.1252
## [2] LC_CTYPE=English_United States.1252
## [3] LC_MONETARY=English_United States.1252
## [4] LC_NUMERIC=C
## [5] LC_TIME=English_United States.1252
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets
## [6] methods   base
##
## loaded via a namespace (and not attached):
##  [1] compiler_3.4.4  backports_1.1.2 bookdown_0.7.11
##  [4] magrittr_1.5    rprojroot_1.3-2 tools_3.4.4
##  [7] htmltools_0.3.6 rstudioapi_0.7  yaml_2.1.19
## [10] Rcpp_0.12.16    stringi_1.1.7   rmarkdown_1.9
## [13] knitr_1.20.3    xfun_0.1        stringr_1.3.1
## [16] digest_0.6.15   evaluate_0.10.1
```

Package names are in bold text (e.g., **rmarkdown**), and inline code and filenames are formatted in a typewriter font (e.g., `knitr::knit('foo.Rmd')`). Function names are followed by parentheses (e.g., `bookdown::render_book()`).

Acknowledgments

There are lots.

1

Population Ecology

1.1 Background information

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

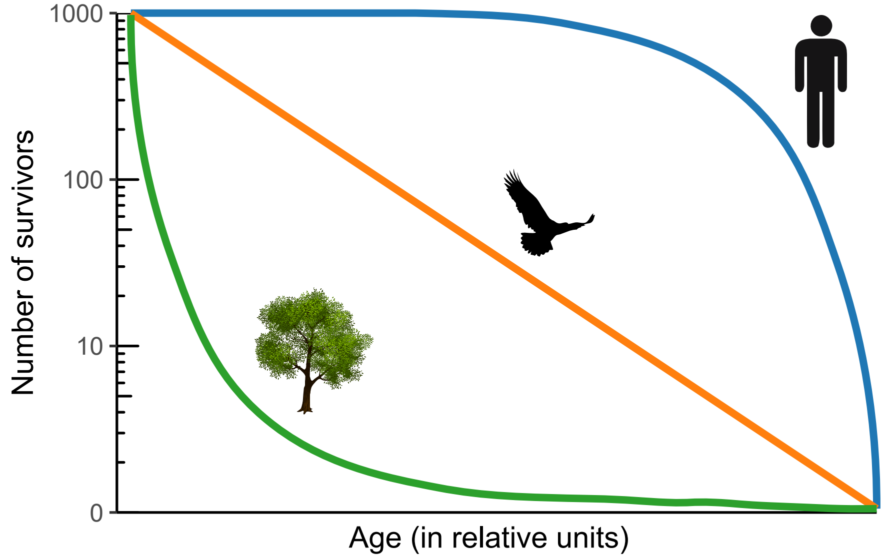

FIGURE 1.1: Idealized examples of Types I, II, and III survivorship curves overlaid with example organisms. Type I survivorship is characterized by high probability of survival early in life, followed by a rapid decline as individuals reach older age. Type II survivorship displays roughly constant mortality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

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?

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...

FIGURE 1.2: Migratory Golden eagle in Denali National Park and 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).

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.

2

Physiological Ecology

2.1 Background information

In the presence of light, photosynthetic organisms can utilize light and carbon dioxide (CO_2) to make sugars - the process of photosynthesis. The sugars made are used by these organisms (and organisms that eat them) as a source of energy. A by-product of the photosynthetic process is the liberation of oxygen (O_2).

At the same time, these organisms are consuming oxygen via respiration. Although respiration and photosynthesis both take place in the light, in the dark only respiration occurs (since photosynthesis is a light-dependent process). Though it is impossible to directly measure gross photosynthesis (or the total amount of O_2 produced, (Wohlfahrt and Gu, 2015), we *can* measure respiration (R) as the **rate of O_2 decrease** in the dark, and the **rate of oxygen increase** in the presence of light as a measure of net photosynthesis (P_{net}). Combining these direct measurements, we can estimate gross photosynthesis (P_{gross}).

$$P_{net} = P_{gross} - R \tag{2.1}$$

Using equation (2.1) can directly measure the terms in blue , and may use them to calculate P_{gross} .

Organisms capable of photosynthesis span an incredible range of phylogeny, from *unicellular algae* to *vascular plants* (Fig. 2.1). While every algae cell is photosynthetic, vascular aquatic plants (i.e. aquatic macrophytes) have large amounts of specialized tissue devoted to the transportation of resources and structural support. As Chapter 1 mentioned, every adaptation is a trade-off.

FIGURE 2.1: Aquatic algae (left pane, both underwater and floating mats) and aquatic macrophytes (right pane) are photosynthetic organisms that evolved in aquatic ecosystems.

2.2 Objectives

We will test hypotheses about photosynthesis using two aquatic organisms - a community of algae and a common aquatic macrophyte.

1. Which aquatic organism, algae or aquatic macrophyte, has the highest rate of *biomass specific* gross photosynthesis (P_{gross})?
2. Which organism has the highest rate of *biomass-specific* respiration?
3. Assuming these organisms photosynthesize at P_{gross} for 10 hours a day and respire for 24 hours a day, which organism has the highest rate of net primary production (P_{net}) per day?

2.3 Materials & methods

330 mL BOD bottles | Light source (> 400 uE m-2S-1) Dissolved O2 meter | Aluminum foil

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.

Wohlfahrt, G. and Gu, L. (2015). The many meanings of gross photosynthesis and their implication for photosynthesis research from leaf to globe. *Plant, Cell & Environment*, 38(12):2500–2507.

Xie, Y. (2015). *Dynamic Documents with R and knitr*. Chapman and Hall/CRC, Boca Raton, Florida, 2nd edition. ISBN 978-1498716963.

Xie, Y. (2018). *bookdown: Authoring Books and Technical Documents with R Markdown*. R package version 0.7.11.

Index

bookdown, ix

knitr, ix