WILD 6500: Biometry
Design and Analysis of Ecological Research
Fall Semester 2017

Instructor: Thomas C. Edwards
NR 126 (office)
t.edwards@usu.edu (E-MAIL)\textsuperscript{1} x72529 (PH)

Class Meetings:
Co-mingled lectures & labs, 0900-1020 TTh, NR 204

Registration Info:
WILD 6500 CRN 53673 3 credits

Office Hours:
TU 1030-1130 (immediately after class)
Second office hrs TBD
By appointment as needed

What is Biometry WILD 6500?
Graduate Biometry is designed to refresh your memory regarding research design and analysis while preparing you for further statistics classes in the Mathematics and Statistics Department and elsewhere on campus. A second purpose is to enhance your statistical skills so that you can design and analyze your graduate research, and critically evaluate research you encounter in the literature. Biometry places heavy emphasis on application of statistical tests to ecological data, and less emphasis on statistical theory.

What are the Course Objectives of Biometry?
Course objectives are to: (1) examine research design from a statistical perspective; (2) show how analysis of data is largely determined by research design and its implementation; and (3) review statistical tools for the analysis of ecological data in the context of design. A fourth objective is an introduction to R as the basis for the management, manipulation, and analysis of ecological data. Computational details of specific analytical techniques will not be covered (i.e., you will not be required to memorize and regurgitate formulae).

Biometry Fall Semester, AY2017-18
Class structure consists of five separate modules that are covered sequentially within the 15-week semester period. All analytical instruction is in R; lectures are PowerPoint-based. All R code and lecture PowerPoints will be made available to registered students.

\textsuperscript{1} Email is your best bet for getting in touch
How is Biometry Structured?
Biometry's five modules are described below. The structure for each module consists of short, pulsed lectures covering one (or more) design and analytical topics. Concurrent with any topic will be analyses directly related to the lecture topic and that will be implemented using R.

Consider, for example, a lecture on simple random, systematic, and stratified random sampling. Once the lecture is completed students will immediately apply R code to data sets and implement the different described sampling procedures. Thus, each 1.5 hr class meeting will involve a lecture plus analyses related to that topic. This provides an immediate link to lecture topics and how R can be used to perform analyses. In short, lectures and labs are now "blended" into one instruction element.

Two weekly "office labs" will be offered as well, where students can meet with me and /other students for detailed discussion on design and analysis topics and use of R to achieve desired research results.

What are the Modules of Biometry?
The five modules that comprise Biometry are:

**MI - Research Design**
Principles of research design for ecological study. Six elements covering: (i) principles of research design, (ii) research question articulation; (iii) experimental design; (iv) design classifications and element; (v) sample-survey studies; and (vi) basics of distributions and probability. Five (5) exercises are associated with this module.

**MII - Descriptive Statistics in R**
Common descriptive statistics in R. Five elements on: (i) numerical descriptive statistics; (ii) graphical descriptive statistics; (iii) assessing distributions; (iv) measures of correlation; (v) basic graphs for portraying descriptive data. Seven exercises are associated with the module.

**MIII - Analysis of Variance Techniques in R**
Analysis of variance techniques in R, including elements on: (i) t-test, 1- and 2-way ANOVA; (ii) ANOVA with blocks; (iii) factorial experiments; (iv) nested designs; (v) repeated measures; (vi) split-plot designs; and (vii) basic mixed models. Multiple comparison and contrast tests are covered as well. Twenty-five exercises are associated with this module.

**MIV - Basic Regression Techniques in R**
Module elements include: (i) simple and multiple linear regression; (ii) analysis of covariance; (iii) Poisson regression; (iv) quantile regression; and (v) regression trees. Diagnostics appropriate to each tool are taught as well. Eleven exercises are associated with the regression module.

**MV - Categorical Methods in R**
Coverage of common tools for analyzing categorical data, including: (i) goodness-of-fit tests; (ii) chi-square analyses; (iii) logit models; and (iv) log-linear models. Eleven exercises are associated with the module.
Analysis with groups of 2-3 of your peers will be strongly encouraged.

**Are there any Pre-Requisites?**
Graduate standing is the only formal pre-requisite. Feel free to contact me if you have any questions as to what this means.

**What about the Use of R in Biometry?**
Students will be expected to have, or be willing to learn concurrent with the modules in Biometry, basic knowledge in use of R to manage and manipulate data. While I will provide instruction in R packages and coding to achieve desired analytical outcomes, I will not have time to provide instruction in basic R procedures such as importing, subsetting and merging, or splitting data. If, for example, the R functions `read.csv()`, `subset()`, `merge()`, or `aggregate()` represent "Greek" to you, you should consider accessing material in my baseR course to learn R, as described next.

**All I Know About R Is that R Is the 18th Letter of the Alphabet …**
Two options exist if you know nothing about R. The first is to formally register for and take baseR, a 1-credit online, self-paced course that provides an introduction to the management and manipulation of data using R. The second is ask me for the baseR material (yes, it is available without formally registering for the baseR course) and pick and choose those parts of the course relevant to basic R functions and procedures you need to learn.

This second options requires dedication on your part as a student to self-learn R since, as noted above, the pace of Biometry will preclude me from investing time into R basics. Send me an email if you want to learn more about baseR, or have additional questions regarding use of R in Biometry.

You should think hard about which option is best for you, and seek your major advisor's guidance. Irrespective of your decision, the pace of Biometry does not allow for time to "learn" R as we perform class exercises. If you are not somewhat comfortable with R code you should definitely peruse the baseR module. I will try, as best as is possible, to provide some advance guidance as to what packages and functions in R you will need to know in advance of each class meeting. This will give you chance to ensure personal competency in coding for maximal gain of the co-mingled lecture-lab material.

**What are the Registration Details for online baseR?**
WILD 6580 LO1 CRN 54166, 1 credit

**What are the Registration Details for Biometry?**
WILD 6500 CRN 53673 3 credits
Are There Any Student Required Tools?
All students must have their own portable computer with access to the USU Bluezone WiFi network. Biometry is designed around individually configured, student-owned and controlled personal computers. Students can thus establish personal profiles, create their own library of R packages, work with whatever R GUI interface (e.g., RStudio, RCommander) they desire, and use a MAC, Windows, or Linux OS; in short, it's your CPU, and your personal analytical environment. Moreover, office interactions are based on students bringing their CPU and work to my office or a designated meeting location.

How am I – the Student - Evaluated?
You are graduate students. As such, I operate under an assumption that you are self-motivated with a desire to learn how to design and analyze your personal research. All of this means there is no reason you should not obtain an A unless you consistently fail to meet exercise submission deadlines. You can expect about 1 exercise a week. There are no formal tests, only exercises. My role is to review your code and output and make suggestions on how to better improve the first and ensure the second is "correct."

Most instances of "wrong" are due to inappropriate application of a particular analytical tool to a given a data structure. Some of the course exercises are, to be fair, vexing, even frustrating. But so will be the analysis of your personal data. Exercises are returned until a "correct" answer is reached. But rather than simple correctness, I instead encourage a so-called 'scientific defensibility" philosophy, whereby careful attention to assumptions and details underlying your design, data collection, and analysis, is expected. Thus answers to your exercises will mimic a large part of your research tenure as a graduate students; I provide the context, questions, and data, which are often "messy," and you will analyze and interpret those data.

We will discuss expectations prior to each specific exercise.

Office Lab Interactions
I will be available for designated time periods throughout the semester for individual or group help. The office hours at the top are tentative office hours until finalized the first week of class, based on the best free time for the maximum number of students.

University/QCNR Statements
Academic Dishonesty:
If I discover that someone has plagiarized all or part of a paper, or cheated on an exam or lab exercise, that person will fail the entire course. Basis for this class policy is found at:

https://www.usu.edu/provost/faculty/student_conduct/academic_integrity.cfm

Accommodation for disabilities:
This university is required by law to help disabled students participate fully in all programs, activities and services. If you have a disability that requires note-takers, interpreters for the deaf, require extended testing time, or face other issues related to a disability, tell me or contact the
Disability Resource Center (DRC) directly, [http://www.usu.edu/drc/](http://www.usu.edu/drc/). Course material can be provided in alternative formats such as large print, audio, diskette, or Braille in cooperation with the DRC. All disabilities must be documented by the DRC.

**Questions?**
Feel free to contact me directly via email or stop by my office, NR 126, if you have any questions.

Regards,

Thomas Edwards, Research Ecologist and Professor, USGS Utah Cooperative Fish and Wildlife Research Unit, and Wildland Resources
t.edwards@usu.edu
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Course Syllabus by Date
Detailed descriptions of each Module are found above.

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
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<tbody>
<tr>
<td>Week 1</td>
<td>29.Aug.2016</td>
<td>MI - Research Design</td>
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<tr>
<td>Week 2</td>
<td>5.Sep.2016</td>
<td>MI - Research Design</td>
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<tr>
<td>Week 3</td>
<td>12.Sep.2016</td>
<td>MI - Research Design</td>
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<tr>
<td>Week 7</td>
<td>10.Oct.2016</td>
<td>MIII - Analysis of Variance Techniques in R</td>
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<td>Week 8</td>
<td>17.Oct.2016</td>
<td>MIII - Analysis of Variance Techniques in R</td>
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<td>Week 11</td>
<td>7.Nov.2016</td>
<td>MIV - Basic Regression Techniques in R</td>
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<tr>
<td>Week 12</td>
<td>14.Nov.2016</td>
<td>MIV - Basic Regression Techniques in R</td>
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<tr>
<td>FINAL</td>
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<td>Completely voluntary discussion at the Owl.</td>
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<td>Date and time to be arranged.</td>
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Class Concepts:

As part of a University-wide effort to better articulate teaching goals, instructors in each class are asked to establish a set of benchmarks based on course concepts by which class instruction can be evaluated. You can, if you wish, view these concepts below as a contract between me and each of you in Biometry WILD 6500. Each of the concepts constitutes an element of the course you will understand by the end of the semester. Details for each, of course, are what the class is about.

On completion of Biometry WILD 6500, you will be able to:

- Understand and apply a 6-step process by which ecological, conservation and natural resource management research can be formulated.

- Differentiate among the three most common types of ecological, conservation and natural resource management research - the experiment, sample-survey, and observational study - and understand the strengths and weaknesses of each of the approaches.

- Generate design models, and associated notation, and know how to use design models to properly formulate research.

- Distinguish among the 5 sources comprising error in design models, and mechanisms by which each source can be eliminated, or minimized.

- Understand the basic concept of probability and its relation to predicted distributions.

- Implement a 3-step process for organizing analysis of research data, consisting of initial data exploration, descriptive statistics, and the proper role of formal analysis.

- Use knowledge of the 4 types of data characterizing your response design to select a general set of appropriate statistical analysis tools.

- Have working knowledge of 5 common classes of statistical analysis tools used for comparing populations, or for assessing relationships, including tools for:
  - determining goodness-of-fit;
  - analysis of variance (ANOVA) models ranging from simple 1-way ANOVA to factorial experiments to nested models to split-plot models;
- non-parametric analogs to ANOVA;
- simple linear and multiple regression for continuous response variables, and the logistic model for nominal responses; and
- multi-factor associative tests such as logit and log-linear analyses.

- Use a common statistical analysis package, **R**, to organize, evaluate, analyze, and interpret ecological and natural resource data.

- Interpret results from statistical analyses, and understand their proper relation to the $p$-value, worlds of inference, and power to detect difference.

**Relevance of Biometry concepts to other graduate course you might take:**

Aside from the obvious importance of design and analysis in all research efforts, you will also be able, on class completion, to apply these concepts to:

- Help aid in understanding the strengths and weaknesses of published literature you will read in other classes, and outside of formal classwork

- Design and determine appropriate analytical pathways of your graduate research for review by your advisor and graduate research committee.