CIEE Global Institute – Monteverde

Course name: Biostatistics and Field Methods (Lab Course)
Course number: (GI) STAT 2401 MOCR
Programs offering course: Monteverde Open Campus Block: STEM and Society
Open Campus track: STEM and Society
Language of instruction: English
U.S. semester credits: 4
Contact hours: 45 lecture and 45 laboratory/field
Term: Fall 2019

Course Description

Statistics and field methods combine to teach students how to approach, gather and analyze observations from the field. Using the R statistics software that is the standard for sciences, students will design experiments and gather data in the field to later statistically analyze. Students will learn about different types of data and how different statistical tests handle them. All common statistics used by field ecologists will be explored. Students will also learn appropriate ways to present data in graphs and tables.

Learning Objectives

By completing this course students will be able to:

- Apply basic sampling techniques and methods in the field.
- Know basic experimental designs.
- Understand when to apply any common statistical test after looking at a dataset.
- Be able to evaluate statistical model assumptions and statistical power.
- Feel comfortable summarizing data for biological presentations/reports.
- Be capable of analyzing data using the R package.

Course Prerequisites

None

Methods of Instruction

Students will attend lectures and related lab and field activities. Lectures will focus on how to apply statistical methods to answer specific biological questions. Field activities will be devoted to learning different field methods and also collecting datasets for statistical analyses.

Assessment and Grading

Participation	20 %
Weekly Quizzes	10 %
Midterm Exam	20 %
Laboratory/Field	30 %
Final Exam	20 %
Total	100 %

Course Requirements

Weekly Quizzes

Each week, students will take a quiz on the previous week's course material, including lectures, labs, activities and readings. Quizzes will have True/False, Multiple Choice, calculations, filling in blanks and short answer questions. Quizzes will cover only new material, but similar questions to those on the quizzes will be seen again on the comprehensive final exam.

Laboratory/Field

Laboratory activities will be focused on learning field methods. Each field method will generate a dataset that will be analyzed according to the topics learned during past lectures. Each activity will result in a worksheet that will be graded. Students will plan and conduct a field project in groups in which they have to analyze the dataset and present the results to the rest of the group.

Lab Assessment (total of 30% for final evaluation)

Lab Worksheets	20%
Group Project	10 %

Midterm and Final Exam

In the middle and at the end of the course, students will take an exam covering all

previous material. As with quizzes, the midterm and final exam will have a variety of question formats, including True/False, Multiple Choice, calculations, filling in blanks and short answer questions but these exams will be open book, open notes with a focus on interpretation of statistical analyses.

Participation

Each student is required to attend all sessions of the course and to participate actively in class discussions, class activities, laboratory or field sessions, field research, with invited speakers and during site visits. Be prepared to read approximately 100-150 pages per week and take notes while doing the readings as well as during lectures and labs.

Attendance Policy

Regular class attendance is required throughout the program, and all unexcused absences will result in a lower participation grade for any affected CIEE course. Due to the intensive schedules for Open Campus programs, unexcused absences that constitute more than 10% of the total course will result in a written warning.

Students who transfer from one CIEE class to another during the add/drop period will not be considered absent from the first session(s) of their new class, provided they were marked present for the first session(s) of their original class. Otherwise, the absence(s) from the original class carry over to the new class and count against the grade in that class.

For CIEE classes, excessively tardy (over 15 minutes late) students must be marked absent. Attendance policies also apply to any required co-curricular class excursion or event, as well as to Internship, Service Learning, or required field placement. Students who miss class for personal travel, including unforeseen delays that arise as a result of personal travel, will be marked as absent and unexcused. No make-up or re-sit opportunity will be provided.

Attendance policies also apply to any required class excursion, with the exception that some class excursions cannot accommodate any tardiness, and students risk being marked as absent if they fail to be present at the appointed time.

Unexcused absences will lead to the following penalties:

Percentage of Total Course Hours Missed	*Equivalent Number of Open Campus Semester classes*	*Minimum Penalty*
Up to 10%	1 content classes, or up to 2 language classes	Participation graded as per class requirements
10 – 20%	2 content classes, or 3-4 language classes	Participation graded as per class requirements; **written warning**
More than 20%	3 content classes, or 5 language classes	Automatic **course failure**, and possible expulsion

Weekly Schedule

NOTE: this schedule is subject to change at the discretion of the instructor to take advantage of current experiential learning opportunities.

Week 1

Class 1.1 Biological variables, sampling and descriptive statistics

Students will learn the different types of variables that are usually collected by field biologists. Populations and samples will be contrasted. Students will also explore how variables can be described using summary statistics and graphs. Measures of central tendency and measurements of dispersion and variability will be discussed.

Reading: Chapter 1 and 3 in Zar.

Lab/Field 1.1 Population size

Students will learn how to estimate the population size of mobile organism using the mark-recapture technique. In groups, students will estimate the size of several populations of an abundant species of ant. The populations and individuals to be sampled will be chosen based on the sampling methods discussed in the previous class.

Week 2

Class 2.1 Sampling and experimental design

How to collect samples in a way that facilitates statistical analysis is essential in research. Students will recognize the difference between random sampling an alternative sampling methods, and will learn the basic and classic experimental designs.

Readings: Chapters 8 and 10 in Krebs

Lab/Field 2.2 Spatial distribution

Students will evaluate the spatial distribution of a plant species in a population in

the field. Sampling methods will be discussed. Students will first test against a random Poisson distribution using goodness of fit test in Microsoft Excel.

Class 2.3 Probability distributions and goodness of fit

Students will explore several common probability distributions. The chi-square, t, binomial, Poisson and normal distributions will be compared. Students will learn how evaluate whether collected data fits a particular probability distribution. Students will explore how to use test to evaluate whether observed categorical data fit expected distributions defined by the researcher. Chi-square, Kolmogorov-Smirnov, Binomial and proportions tests will be covered.

Reading: Sections Chapter 6, Sections 22.1-22.3, 23.5, 23.6, 23.13 and 24 in Zar.

Week 3

Class 3.1 Hypothesis testing: Comparisons of one or two means

Students will learn how to use the T-test to compare one sample against a theoretical mean, and how to compare means from two independent samples and from paired samples.

Readings: Sections 7.1-7.3, 8.1, 8.2, 9.1,9.2 in Zar

Lab/Field 3.1 Introduction to R

Students will start exploring the R programing language, making use of field data collected in past labs. They will recalculate summary statistics learn how compare means in R using the data previously collected in the field.

Class 3.2 One-way Analysis of Variance (ANOVA)

Simple cases for one-way analysis of variance will be discussed and the students will recognize why multiple means should not be compared using pairwise t-tests. Independent contrasts and multiple comparisons will be discussed.

Readings: Sections 10.1,10.2, 11.1-11.5 in Zar.

Lab/Field 3.2 Forest structure

The goal of this activity is comparing tree density and tree biomass between habitats. In groups students will collect data on tree height and diameter in plots. The number of trees per plot will be recorded as well. Students will estimate tree height using different methods. Diameter and height will be used to estimate above ground tree biomass. Students will compare diameters, heights and biomass between habitats using the appropriate test for comparisons of means in R.

Class 3.3 Test assumptions and non parametric tests

Parametric tests usually assume normal distribution of residual errors and homogeneity of variances. Students will learn how to test for these assumptions. Non-parametric equivalents to the t-tests and one-way ANOVA will be discussed.

Readings: Sections 8.9-8.11, 9.5-9.7, 10.4 and11.6 in Zar.

- Midterm Exam

Week 4

Class 4.1 Correlation Analysis

Students will explore how to test whether two continuous variables are related to each other using correlation tests. Parametric and non parametric equivalents will be discussed.

Readings: Sections 19.1-19.3 in Zar.

Lab/Field 4.1 Estimating population densities using transects

Students will use the Line Transect Method to estimate the densities of local mammal species. In groups, students will sample different transects in different habitats to sample mammals. Densities will be compared between habitats one-way ANOVA or a non-parametric equivalent. Tests will be conducted in R.

Class 4.2 Data Transformations

Field and laboratory data are usually non-normally distributed or do not follow a linear trend. Students will learn that sometimes it is possible to transform the data to meet the assumptions of linearity and normality required by most of the tests.

Readings: Chapter 13 in Zar.

Lab/Field 4.2 Sampling diversity using point counts

In groups, students will sample bird diversity, abundance and richenss using the point count method in different habitats. The variables will be compared between habitats using Analysis of Variance. Correlations between variables will be calculated in R.

Class 4.3 Simple Linear Regression

Cause-effect relationships will be explored using linear regression. The test of slope and the meaning of the coefficient of determination will be discussed.

Readings: Sections 17.1-17.6 in Zar.

Week 5

Class 5.1 Analysis of Covariance (ANCOVA)

ANOVA will be extended to include a continuous covariate. This is equivalent to comparing multiple linear regression equations. Students will learn how to test for interactions between the covariate and the categorical factor.

Readings: Section 12.12, Chapter 18 in Zar.

Lab/Field 5.1 Camera traps

Students will learn how to set up camera traps to take pictures of large animals. They will install cameras in several habitats and leave them out for several days before returning to collect the data.

Class 5.2 Power analysis and sample size requirements

Students will recognize the benefit of knowing the sample size required to reject a null hypothesis before designing an experiment. They will learn how to calculate the power to reject a false null hypothesis for each specific previously studied statistical tests.

Reading: Respective sections for power and sample size in chapters 7-12, 17 and 19.

Lab/Field 5.2 Mist nets and camera trap data

Students will learn how to set up mist nets to capture birds and bats. They will also learn how to extract birds and/or bats from nets. Mist net data will be analyzed along with the camera trap data.

Class 5.3 Two-way ANOVA

Adding another categorical factor will complicate the simplest case of the one-way ANOVA. The factorial design and the concept of interaction between factors will be discussed. Effect sizes and confidence intervals will be explored.

Readings: Sections 12.1-12.3, 12.6 and 12.7 in Zar

Week 6

Class 6.1 Nested ANOVA

Students will recognize the difference between the crossed experimental design of the factorial design analyzed before and a hierarchical experimental design

analyzed with a Nested ANOVA.

Reading: Chapter 15 in Zar.

Lab/Field 6.1 Field problem

Students will be given several research questions on organisms that have not yet been sample during the proram (e.g. aquatic Insects). In groups, they will discuss the appropriate experimental design and collect the data. Students will analyze the datasets on their own and present the results on the following lab session.

Class 6.2 Repeated measures ANOVA.

The paired t-test concept will be extended to more than two replicates. Classic analytical (ANOVA, non parametric) versus modern numerical ways (Mixed-Effects Models) to analyze repeated measures designs would be explored.

Readings: Sections 12.4, 12.8-12.11, Chapter 19 in Crawley.

Lab/Field 6.2 Student presentations

Groups will present the results of their field problem

Class 6.3 Review

- Final Exam

Course Materials

Course Textbook

Zar, J.H. 2010. Biostatistical Analysis, 5th Edition.
Krebs, CH. 1999. Ecological Methodology, 2nd Edition.
Michael J. Crawley. 2013. The R book, Second Edition (optional). First edition can be found free online and it is good enough for this course.