Last Updated: August 24, 2016

BIOMETRY
(BIOL 4090)

www.pelagicos.net/classes_biometry_fa16.htm

HAWAII PACIFIC UNIVERSITY	TIME: 9:10 – 10:35
HAWAII LOA CAMPUS (HLC)	DAYS: Tuesday & Thursday
FALL SEMESTER, 2016	ROOM: AC 205, HLC

INSTRUCTOR

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OFFICE HOURS

Tuesday / Thursday (HLC AC 2nd floor lanai) 10:45 - 12:00
… or by appointment

Texts:

Required: Discovering Statistics Using SPSS, 3rd or 4th ed, 2009 or 2013, Andy Field, Sage Publications, Thousand Oaks (USA), ISBN 978-1-84787-906-6

Recommended: A Primer of Ecological Statistics, 2004, Nicholas Gotelli and Aaron Ellison, Sinauer Associates Inc., Sunderland (USA), ISBN: 0878932690 (On Reserve at HLC Library)

Reference Web-sites:

You are encouraged to use the student resources, including example datasets and self-test answers, posted on the publisher's web-site: http://studysites.sagepub.com/field4e/

You are also encouraged to use this free online Elementary Statistical Concepts textbook, at: http://documents.software.dell.com/Statistics/Textbook/elementary-statistics-concepts

Software:

- Licenses available at desktops at the Hawai'i Loa Campus 3rd floor learning computer center.
- You can also access the software via the virtual desktop: http://www.hpu.edu/vdi/
- You can also rent a personal PC or MAC copy of SPSS 24 "standard grad pack" for 6/12 months ($ 60 / $95) at: http://www.onthehub.com/spss/ (NOTE: make an account on site)

Prerequisite:

Any introductory statistics course, in either Biostatistics or Mathematics.

Scope:

This course is designed to provide an introduction to experimental design, hypothesis testing, data analysis, and statistical result interpretation and presentation. Topics covered include statistical distributions, ANOVA applications, regression and correlation, power analysis, and contingency / chi-square tests. Instruction on statistical theories and methods will be enhanced by discussing examples drawn from the scientific literature and conducting analyses using SPSS software.

Learning Outcomes:

- The main focus of this course is to provide students with the baseline of knowledge and the tools to perform and interpret statistical analyses of biological data. To this end, students will:
    - Develop the ability to state testable hypotheses and design tests to evaluate those hypotheses in a scientifically sound manner. Students will determine which methods of analysis will best test the hypotheses and which underlying assumptions are required.
    - Evaluate the assumptions specific to the various statistical parametric / non-parametric statistical methods and to determine whether data transformations can be used to meet these assumptions. Given this evaluation, students will evaluate and report the strength of the statistical inference and determine which analytical methods are most appropriate.
    - Learn the different types of numerical data (nominal, ordinal, ratio, scale, categorical, continuous) and what options are available for their analysis.
    - Study the metrics and methods used for quantifying data distributions.
    - Evaluate the strengths and weaknesses of various numerical analysis, including the techniques for organizing, re-coding, and transforming the data.
    - Explore how experimental design influences data analysis, including how to reduce the likelihood of type I (false positive) and type II (false negative) statistical errors.

- Another major focus of this course is to review the philosophical underpinnings and practice of the scientific method. Students will learn how experimental controls and sample size influence the findings of significance for a variety of analyses. Through discussions of power analysis and post-hoc tests, students will critically examine the reasons for non-significant outcomes.

- More specifically, students who successfully complete this course will be able to:
    - Understand the mechanics and theory of statistical testing, and the associated terminology: p-value, critical value, alpha, significance, type-I error, type-II error.
    - Understand the use of inferential and descriptive statistics
    - Understand the concept and function of the "null / alternate hypothesis" and be able to formulate hypotheses for their own research questions
    - Statistically analyze and interpret data using the procedures covered in this course
    - Identify the appropriate analytical procedures for a variety of data sets
    - Present data and statistical results in tabular and graphical format
    - Effectively analyze and present statistical notions (mean, median, mode, range, standard deviation, standard error, coefficient of variation, variance, confidence interval) by hand
    - Effectively analyze and present data using the statistical software package SPSS
    - Understand the limitations of the statistical procedures learned in class, and be able to critically analyze statistics used in the literature

- Achievement of these outcomes will be assessed with homework, exams and class participation

Reading Assignments:

- To fully understand the theories, assumptions and output of the analytical procedures presented in this course it is essential to carefully read all assignments in the text books.
- You are advised to read the material before coming to lecture.
- The texts complement each other: *Gotelli and Ellison* being more traditional and more applicable to many of the real-world scientific questions; *Field* focuses on explaining the mechanics of performing statistical tests and how to use the SPSS software in data analysis.

Academic Honesty:

It is academically dishonest to try to pass off someone else's intellectual work as your own, or to help someone else to do so. Thus, **there are no circumstances under which including someone else's writing or results in your papers or assignments is permissible**.

Plagiarism will result in a zero on the assignment, and issuance of an academic dishonesty report to the University's Office of Academic Affairs. Serious cases of academic dishonesty will lead to an "F" in the course and may lead to expulsion from the University. Students are expected to comply with HPU's Academic Honesty Policy, which is described on the student services web-site: http://www.hpu.edu/StudentServices/AcademicIntegrity/

Other Class Policies:

Attendance - Attendance is mandatory; however roll will not be taken. There will be no make-up quizzes except in the case of documented medical necessity.

Coming to class late - Tardiness disturbs others and will not be tolerated. If you must come late or leave early discuss the need with me and try to make as small a disturbance as possible.

Cell phones are ***never*** to be used in class, turn them off before entering the room.

Laptops are allowed to take notes / view the lecture pdfs. This is a privilege which will be revoked if laptops are used for non-class activities (e.g., email / facebook).

Grading:

I will use the following scale, with +s and –s to assign grades:

92 - 100%	A	90-91	A-		
87 - 89%	B+	82-86	B	80-82	B-
77 - 79%	C+	72-76	C	70-71	C-
67 - 69%	D+	60-66	D		
>60%	F				

Grading will be based on quizzes, a final exam, and class participation. The quizzes and final exam will be cumulative and may include questions from previous quizzes. The majority of the content covered on a quiz will be from the previous week's lectures and associated reading assignments.

NOTE: The homework sets are study guides for the quizzes and will not be graded. Make sure you do the homeworks and go over the quiz keys. I will revisit issues students are having trouble with.

1. **Quizzes: 50% (there will be 11 quizzes (5 points each) - you can drop your lowest score)**
   - Quizzes will be administered at the start of class and will last 30 minutes.
   - They will focus on the material covered since the previous quizz.
   - Questions from previous quizzes will be included.
   - The lowest quiz score will be dropped.
   - There will be no make-up quizzes.

2. **In-Class Final (on 12/8, 9:10- 11:35 a.m.): 20%**
   - The final exam will be administered during final's week and will last 120 minutes.
   - This exam is cumulative and will include material from readings, quizzes and homeworks.

3. **Take Home Final (due on 12/8 at the in-class final exam): 20%**
   - You will be provided with data sets and hypotheses to be tested.
   - You will turn in:

     a. A "methods" narrative explaining how you chose the statistical procedures, and describing whether the assumptions underlying each test were met. To get full credit, explicitly state which analyses were used to test the assumptions, to perform the main comparisons and – if relevant – to make post-hoc comparisons. Use format and structure appropriate for a results section in a scientific manuscript.
     b. A "results" narrative explaining the outcome and interpretation of the analyses for the various tests and working hypotheses. To get full credit, make sure you use the format and structure appropriate for a results section in a scientific manuscript.
     c. Figures and tables summarizing the data and results. To get full credit, make sure you use format and structure appropriate for a results section in a scientific manuscript.

4. **Participation: 10%**
   Students will be evaluated on their effort and commitment to learning. This includes class attendance, readiness, and – if necessary - seeking extra help in class or office hours.

   Students will review the homeworks and readings before coming to class. The instructor will assess student preparedness in class, using pop-quizzes and 5-minute papers at the beginning and the end of class. Students will be evaluated qualitatively (+ / -).

Last Updated: August 24, 2016

Class Schedule: August 30 – December 9:

This is a tentative schedule, which may speed up / slow down as needed, to keep up with student learning and performance. Revised schedules will be posted periodically, throughout the semester:

Date	***Topics***	***Reading Assignment***
8/30	**Introduction – Three Statistical Frameworks**	Gotelli: Chapter 5
9/1	**The Scientific Method & Hypothesis Testing**	**Field: Chapter1** Gotelli: Chapter 4
9/6	**Describing Observations**	**Field: Chapter1** Gotelli: Chapter 1
9/8	**Sampling & Probability** *Quiz 1*	**Field: Chapter1** Gotelli: Chapter 1
9/13	**Conditional Probability**	
9/15	**Estimation: central tendency and variation** *Quiz 2*	**Field: Chapter 2** Gotelli: Chapter 3
9/20	**Statistical Inference & Reliability**	
9/22	**Probability Distributions – I** *Quiz 3*	**Field: Chapter 3** Gotelli: Chapter 2
9/27	**Probability Distributions - II**	**Field: Chapter 3 & 4**
9/29	**Parametric Statistics: Assumptions & Data Exploration** *Quiz 4*	**Field: Chapter 4 & 5**
10/4	**Data Transformations**	**Field: Chapter 5.7** Gotelli: 223-236
10/6	**Descriptive Statistics** *Quiz 5*	**Field: Chapter 3 & 4**
10/11	**Dealing with the lack of Normality**	
10/13	**Statistical Modeling & Hypothesis Testing** *Quiz 6*	
10/18	**Correlation Analysis**	**Field: Chapter 6**
10/20	**Simple Linear Regression Analysis** *Quiz 7*	**Field: Chapter 7** Gotelli: Chapter 9
10/25	**Multiple Regression Analysis**	**Field: Chapter 7** Gotelli: Chapter 9
10/27	**Comparing two or more means** *Quiz 8*	**Field: Chapter 9**

Date	*Topics*	*Reading Assignment*
11/1	**Analysis of Variance with Planned Comparisons**	**Field: Chapter 10** Gotelli: 289-302 Gotelli: 325-348
11/3	**Analysis of Covariance (ANCOVA)**	**Field: Chapter 11** Gotelli: 314-317
11/8	**Multifactor Analysis of Variance**	**Field: Chapter 13** Gotelli: 309-314
11/10	**Multifactor Analysis of Variance - Nested / Factorial Designs** *Quiz 9*	**Field: Chapter 13** Gotelli: 309-314
11/15	**Applications - Categorical Data (cross-tabulation / Chi-Square)**	**Field: Chapter 18** Gotelli: Chapter 11
11/17	**Applications – Nonparametric tests**	**Field: Chapter 15**
11/22	**Applications – Statistical Power** *Quiz 10*	Gotelli: Chapters 6 & 7
11/24	**NO CLASS – Thanksgivings Holiday**	
11/29	**Review and Wrap - up** *Quiz 11*	
12/1	**Preparation for Finals - Jeopardy Contest**	
12/8	**Final's Week - Final Exam (in class: 9:10- 11:25 a.m.)**	
12/8	**Final's Week - Take Home Exam Due (Bring to Final Exam)**	

Take-Home Exam: Due: Thursday, 12/8, 9:10 a.m. (NOTE: final in room AC 205)

Final Exam: Thursday, 12/8, 9:10 a.m. - 11:35 a.m. (NOTE: final in room AC 205)

Extra Readings (for Reference):

Anderson D.R., Burnham K.P., Thompson W.L. (2000) Null hypothesis testing: problems, prevalence, and an alternative. Journal of Wildlife Management, 64(4): 912–923.

Berger J.O., Berry D.A. (1988) Statistical analysis and the illusion of objectivity. American Scientist, 76: 159–165.

Chamberlin, T.C. (1890) The method of multiple working hypotheses. Science 15: 92 (reprinted in Science 148: 754-759).

Day, R.W. and G.P. Quinn (1989) Comparisons of treatments after an analysis of variance in ecology. Ecological Monographs 59: 433-463.

Dayton P.K. (1998) Reversal of the burden of proof in fisheries management. Science, 279: 821–822.

Glass, G.V., P.D. Peckham, and J.R. Sanders. 1972. Consequences of failure to meet assumptions underlying the fixed effects analyses of variance and covariance. Review of Education Research, 42: 237-288.

Gardner M.J., Altman D.G. (1986) Confidence intervals rather than P values: estimation rather than hypothesis testing. British Medical Journal, 292: 746–750.

Germano J.D. (1999) Ecology, statistics, and the art of misdiagnosis: the need for a paradigm shift. Environmental Review, 7: 167–190.

Gerrodette T. (1987) A power analysis for detecting trends. Ecology, 68: 1364–1372.

Gerrodette, T. (2011) Inference without significance: measuring support for hypotheses rather than rejecting them. Marine Ecology – An Evolutionary Perspective, 32 (3): 404–418.

Goodman S.N., Berlin J.A. (1994) The use of predicted confidence intervals when planning experiments and the misuse of power when interpreting results. Annals of Internal Medicine, 121(3): 200–206.

Gray B.R., Burlew M.M. (2007) Estimating trend precision and power to detect trends across grouped count data. Ecology, 88(9): 2364–2372.

Guthery F.S. (2008) Statistical ritual versus knowledge accrual in wildlife science. Journal of Wildlife Management, 72(8): 1872–1875.

Hurlbert, S.H. (1984) Pseudoreplication and the design of ecological field experiments. Ecological Monographs 54: 187-211.

Hurlbert, S.H. and C.M. Lombardi (2009) Final collapse of the Neyman-Pearson decision theoretic framework and rise of the neoFisherian. Ann. Zool. Fennici, 46: 311-349.

Johnson D.H. (1999) The insignificance of statistical significance testing. Journal of Wildlife Management, 63(3): 763–772.

Johnson D.H. (2002) The role of hypothesis testing in wildlife science. Journal of Wildlife Management: 66(2), 272–276

Lombardi, C.M., and S.H. Hurlbert (2009) Mispresentation and misuse of one-tailed tests. Austral Ecology, 34: 447-468.

McBride G.B., Loftis J.C., Adkins N.C. (1993) What do significance tests really tell us about the environment? Environmental Management, 17(4): 423–432.

Meeks S.L., D'Agostino R.B. (1983) A note on the use of confidence limits following rejection of a null hypothesis. The American Statistician, 37(2): 134–136.

Nakagawa S., Cuthill I.C. (2007) Effect size, confidence interval and statistical significance: a practical guide for biologists. Biological Reviews, 82(4): 591–605.

Peterman R.M., M'Gonigle M. (1992) Statistical power analysis and the precautionary principle. Marine Pollution Bulletin, 24(4): 231–234.

Platt J.R. (1964) Strong inference. Science, 146: 347–353.

Philips, P. C. (1998) Designing Experiments to maximize the Power of detecting correlations. Evolution 52 (1): 251-255.

Preece D.A. (1984) Biometry in the Third World: science not ritual. Biometrics, 40: 519–523.

Quinn J.F., Dunham A.E. (1983) On hypothesis testing in ecology and evolution. The American Naturalist, 122(5): 602–617.

Robinson D.H., Wainer H. (2002) On the past and future of null hypothesis significance testing. Journal of Wildlife Management, 66(2): 263–271.

Skipper J.K. Jr, Guenther A.L., Nass G. (1967) The sacredness of 0.05: a note concerning the uses of statistical level of significance in social science. American Sociologist, 2: 16–18.

Steidl R.J., Hayes J.P., Schauber E. (1997) Statistical power analysis in wildlife research. Journal of Wildlife Management, 61(2): 270–279.

Stephens P.A., Buskirk S.W., Martınez del Rio C. (2006) Inference in ecology and evolution. Trends in Ecology and Evolution, 22: 192–197.

Taylor B.L., Gerrodette T. (1993) The uses of statistical power in conservation biology: the vaquita and northern spotted owl. Conservation Biology, 7: 489–500.

Thomas L. (1997) Retrospective power analysis. Conservation Biology, 11: 276–280.