Biometry

BIOL 502 & 502L

Fall 2012

Lecture: Tuesday & Thursday 5:00-6:15 pm Chaparral 5329
Lab: Tuesday & Thursday 6:30-7:45 pm Chaparral 5329

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Course website: ***www.csun.edu/~msteele/classes/biometry/Biometry.htm***

Required Book:

Experimental Design and Data Analysis for Biologists. **2002. Gerry P. Quinn and Michael J. Keough. Cambridge University Press.**

Supplemental Texts (optional):

Biometry: The Principles and Practices of Statistics in Biological Research. Robert R. Sokal and F. James Rohlf

Biostatistical Analysis. Jerrold H. Zar

A Repertoire of Biostatistics. Paul Wilson (request book #9940882 at the Textbook Information Desk at the CSUN Bookstore)

Course Objectives: This course is intended to provide you with a general understanding of how and why to conduct various statistical analyses on biological data. My goal is that by the end of the course, you will understand the theory and practice of statistical analysis well enough that you will be able to:

1. Design and analyze your own biological studies (e.g., your thesis research).
2. Evaluate whether other studies (published or otherwise) were analyzed correctly.

Course Overview: This course combines a series of lectures with extensive hands-on statistical analysis of biological data. My intention is to involve you as an active participant – in lectures and lab. *You are encouraged and expected to ask questions during lecture and lab.* It is especially true of a statistics course that if you are uncertain about something, it is likely that other students are, too. During lab, you are encouraged to discuss what you are doing with your fellow students, because in explaining things to one another, you will gain a deeper understanding of the material.

In lectures you will learn the theory underlying the statistical methods that you will employ using statistical programs during the lab portion of the class. It is essential that

you understand basic theories, assumptions, and limitations of statistical methods because it is very easy to get statistical packages to analyze data in completely inappropriate ways.

In lab, you will learn the mechanics of analyzing biological data. Do not view this work as busy work – you really only become proficient at analyzing data by practicing. The more practice, the more proficient you will become, and the better able to analyze your own data you will be.

Grading:

Component	Percent of Grade
Problem Sets	45
Midterm Exam 1	15
Midterm Exam 2	15
Final Exam	20
Paper Critiques	5
TOTAL	100

Your grade will be based on the components listed above. You will receive the same grade for both parts of the class, 502 and 502L. **Problem sets** will account for 45% of your grade. The problem sets will give you the practical experience necessary to become proficient with statistical analysis. You are allowed to talk about and collaborate with other students on these problem sets, but ultimately, if you do not do all the exercises in a problem set yourself, you will not gain a firm grasp of the material.

There will be 3 exams: 2 midterms and a final. The final will be cumulative. The **exams** will have two components: a written component based on lecture material that will be "closed-book"; and a lab component in which you analyze data on the computer. For the lab component, you can refer to lecture notes, your text book, problem sets, the internet, the help section of the program you use to analyze data, etc., but you may not collaborate with fellow students on either portion of the exams. The lecture-based portion of exams will consist of short answer questions (one word to one short paragraph), true/false, and graphs or other figures, which test your ability to synthesize information from lecture and think logically about its implications. The lab component will test your ability to choose and execute appropriate statistical analyses. **There are no make-up exams.** In *exceptional cases*, and if arrangements have been made *in advance*, exams may be taken at a different, mutually agreed upon time (usually before the rest of the class).

Paper critiques will make up the remaining 5% of your grade. There will be two of these. For each of these, each of you will choose a published paper in your field of interest that you think offers either a very good example of a well-posed and tested hypothesis that is analyzed appropriately, or one that you think is flawed. You will write a brief (1 page) explanation of your point of view, and in front of the class, you will briefly (a few minutes) describe the hypothesis, test (i.e., experiment or observations), and analysis of the data. You may not choose the same paper as another student, unless you choose the opposite position on it.

Your grade will be based on your percentage of the total possible points. You can use the following cutoffs as a guideline. I reserve the right to lower the grade cutoffs.

Percent	Letter Grade
93-100	A
90-92	A-
88-89	B+
83-87	B
80-82	B-
75-79	C+
70-74	C
65-69	C-
60-64	D+
55-59	D
<55	F

Exam Dates:	Midterm 1:	October 2, 5:00 – 7:45 pm
	Midterm 2:	November 6, 5:00 – 7:45 pm
	Final (Lab):	December 6, 5:00 – 7:00 pm
	Final (Lecture):	December 11, 5:30 – 7:30 pm

Attendance: This is a challenging and time-demanding course. You are expected to attend and actively participate in every lecture and lab.

Communication: Outside of class time, I will communicate with you via your CSUN email account. If you do not normally use this account, please configure your CSUN account to forward your messages to your preferred account. You can expect me to respond to your email within 24 hours (except on weekends).

Your best source of course information is the course website. Lecture handouts (pdf's of the PowerPoint lectures), pdf's of required readings (scientific papers), class assignments, various handouts, and data files for problem sets are downloadable from the website.

Expectations: You can expect us to be punctual, to treat you fairly, to return your graded assignments in a timely fashion, and most importantly, to treat you with respect. In return, I expect you to treat other students, the GA, and me with respect and do everything you can to ensure a comfortable learning environment. For example, jokes or comments made in poor taste that make any member of the class uncomfortable will not be tolerated. Use of cell phones or computers during class for any purpose other than those directly related to the class is not allowed.

We expect that you will frequently need help with this class. Don't be embarrassed by this. Ask questions of us during lecture, lab, and office hours. Your fellow students can also be excellent sources of help.

Policies:

- **Cheating** on an exam will result in failure of the course and may result in further University discipline. The CSU policy states: *"Cheating or plagiarism in connection with an academic program at a campus is listed as an offense for which a student may be expelled, suspended, or given a less severe disciplinary action."*
- **Plagiarism** will result in you failing the assignment. Plagiarism is *"intentionally or knowingly representing the words, ideas, or works of another as one's own in any academic exercise"*. Don't do it. Remember to give full credit to authors and cite them in your research reports.
- **Late assignments lose 10% per day**, i.e., the most you can receive for an assignment that is one day late is 90% of its point value, 2 days late 80%, etc. Once the answers to the problem sets are posted, late assignments will not be accepted.
- **Punctuality**: expect to start on time.
- Students with **disabilities** must register with the Center on Disabilities and complete a service agreement each semester. Staff within the Center will verify the existence of a disability based on the documentation provided and approved accommodations. Students who are approved for test taking accommodations must provide an Alternative Testing Form to their faculty member signed by a counselor in the Center on Disabilities prior to making testing arrangements. The Center on Disabilities is located in Bayramian Hall, room 110. Staff can be reached at 818-677-2684.
- The Biology Department **withdrawal policy** states: *"Unrestricted withdrawals are permitted only until the end of the third week. Thereafter, requests to drop a class will be honored only when a verifiable serious and compelling reason exists and when there is no viable alternative to withdrawal. Poor performance is NOT an acceptable reason for withdrawal. During the last three weeks of the semester withdrawals will not be approved except when a student is withdrawing from ALL classes for verifiable medical reasons."*

Optional Reading List †

Note: the purpose of this list is to provide "advanced" reading on topics that will be useful for research. These are not intended to be mandatory reading for this course, rather they are for your reference.

Clarke, K. R. & R. M. Warwick. 2001. Change in Marine Communities: An approach to statistical analysis and interpretation. PRIMER-E Ltd. Plymouth, U. K.

Csada, R. D., James, P.C., and Espie, R. H. M. 1996. The "file drawer problem" of non-significant results: does it apply to biological research? Oikos 76: 591-594.

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

Dutilleul, P. 1993. Spatial heterogeneity and the design of ecological field experiments. Ecology 74: 1646-1658.

Fairweather, P. G. 1991. Statistical power and design requirements for ecological monitoring. Australian Journal of Marine and Freshwater Research 42: 555-568.

Green, R. H. 1989. Power analysis and practical strategies for environmental monitoring. Environmental Research 50: 195-205.

Greenwood, J. J. 1994. Statistical analysis of experiments done at multiple sites. Oikos 69: 334.

Hargrove, W. W., Pickering, J. 1992. Pseudoreplication: a sine qua non for regional ecology? Landscape Ecology 6: 251-258.

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

Legendre, P. 1993. Spatial autocorrelation: trouble or new paradigm? Ecology 74: 1659-1673.

Lively, C. M., McKone, M. J. 1994. Choosing an appropriate ANOVA for experiments conducted at multiple sites. Oikos 69: 335.

Mapstone, B. D. 1995. Scalable decision rules for environmental impact studies: effect of size of Type I and Type II errors. Ecological Applications 5: 401-410.

McGarigal, K., S. Cushman and S. Stafford. 2000. Multivariate Statistics for Wildlife and Ecology Research. Springer-Verlag Press, Berlin.

McKone, M. J., Lively, C. M. 1993. Statistical analysis of experiments conducted at multiple sites. Oikos 67: 184-186.

Peterman, R. M. 1990. Statistical power analysis can improve fisheries research and management. Can. J. Fish. & Aquat. Sci. 47: 2-15.

Peterson, C. H. 1993. Improvement of environmental impact analysis by application of principles derived from manipulative ecology: lessons from coastal marine case histories. Australian Journal of Ecology 18: 21-52.

Petraitis, P. S., Dunham, A. E., Niewaiarowski, P. H. 1996. Inferring multiple causality: the limitations of path analysis. Functional Ecology 10: 421-431.

Petraitis, P. S. and S. R. Dudgeon. 2004. Do alternative stable states exist in the Gulf of Maine rocky intertidal zone? A comment. Ecology 85(4): 1160-1165.

Potvin, C., Tardiff, S. 1988. Sources of variability and experimental designs in growth chambers. Functional Ecology 2: 123-130.

Potvin, C., Roff, D. A. 1993. Distribution free and robust statistical methods: viable alternatives to parametric statistics. Ecology 74: 1617-1628.

Rotenberry, J. T., Wiens, J. A. 1985. Statistical power analysis and community-wide patterns. American Naturalist 125: 164-168.

Shaw, R. G., Mitchell-Olds, T. 1993. ANOVA for unbalanced data: an overview. Ecology 74: 6.
Shen, J. 1995. On choosing an appropriate ANOVA for ecological experiments. Oikos 73: 404.
Shrader-Frechette, K. S., McCoy, E. D. 1992. Statistics, costs and rationality in ecological inference. Trends in Ecology and Evolution 7: 96-99.
Schroeter, S. C. et al. 1993. Detecting ecological effects of environmental impacts: a case study of kelp forest invertebrates. Ecological Applications 3: 331-350.
Stewart-Oaten, A., Murdoch, W. W. 1986. Environmental impact assessment: "pseudoreplication" in time? Ecology 67: 929-940.
Stewart-Oaten, A., Bence, J. R., Osenberg, C. W. 1992. Assessment effects of unreplicated perturbations: no simple solutions. Ecology 73: 1396-1404.
Toft, C. A., Shea, P. J. 1984. Detecting community wide patterns: estimating power strengthens statistical inference. American Naturalist 122: 38-45.
Underwood, A, J. 1981. Techniques of analysis of variance in experimental marine biology and ecology. Oceanography and Marine Biology Annual Review 19: 513-605.
Underwood, A. J. 1991. Beyond BACI: experimental designs for detecting human environmental impacts on temporal variations in natural populations. Australian Journal of Marine and Freshwater research 42: 569-587.
Underwood, A. J. 1997. Experiments in ecology: Their logical design and interpretation using analysis of variance. Cambridge University Press. 504 pp.

[†]-Courtesy of Steve Dudgeon (CSUN), adapted from Drs. Jon Witman (Brown University, Providence, RI) and Peter Edmunds (CSUN).

A note about Statistical Software

The Biology department and the College of Science and Mathematics have site licenses for SYSTAT and SAS for use in courses that require quantitative analyses (Biol. 330 and 502). We will use SYSTAT for this course. It is one of the better statistical packages available, and among the best menu-driven analysis packages. It is also what I use. It has been installed on the computers in various computer labs in College of Science and Mathematics, but site-license restrictions preclude it being installed elsewhere.

You are welcome to use other statistical packages, but you will be on your own in figuring out how to use them. For example, the department also has a site license for SAS (The Statistical Analysis System). SAS is perhaps the most powerful and flexible software package for data analysis, and it is excellent for database management, but it requires the user to write code. I do not like to write code, and I find that many students (myself included) spend more time and mental energy on writing code than on thinking about the statistical analyses they are performing.

JMP is a scaled down (limited), menu-driven version of SAS that is quite good, though not as robust as SYSTAT or SAS. SPSS and STATISTICA are also good programs.

Increasingly, R is being used by biologists. R is a computer language and environment for statistics and graphing. It has many of the strengths of SAS, but it is free and has open source code. Like SAS, you have to learn the code to run the program. My guess is that over the long-term, R will supplant SAS.

Choose the program you like best if you already have a preference. Otherwise, I'd suggest you invest in SYSTAT because it is a great program that we'll be able to help you with. You could try MYSTAT, which is a stripped down, free version of SYSTAT, but it has been stripped of much of the more complicated statistics. If you can't afford SYSTAT, plan on spending a lot of time in the computer labs.