1 General Information

Projects in which students design their own study, obtain, analyze their own data and write up their results contribute to greater motivation and enhanced understanding of the material. Since all of you in this course are in the biological, environmental or agricultural sciences, I would like to use an approach that ties the project in this class to your interests.

Your participation in a project is **entirely optional**. In addition to the benefits described in the previous paragraph, here is what's in for you. If you choose the project, it can **either** count for honors, **or** it can help your grade in the following way. If your score on the project is higher than your score in any of the in-class exams, I will modify the lowest exam score as follows. If your lowest exam is on a midterm, it will be replaced by the project score. If your lowest exam score is on the final, the final will count for 20% of the grade (instead of 40%) and the project score will count for 20%. I anticipate that the typical scores on projects will be comparable to the typical scores on exams.

I will ask you to decide on your commitment to an optional project prior to the first exam. The deadline for signing up for a project will be Tuesday **Feb. 21**st. On or before that day, I will ask you to fill out a brief form that I will make available on the web, in which you commit to completing a project. You can do a project by yourself, or with a group of up to 3 students. If you do a group project, you can hand in a single group report. However, I will ask all members of the group to indicate in writing that all of you contributed approximately equally to the project. I want to emphasize two points.

1. The project should be of the right **scope**. Certainly it means that it should not be too simple-minded. However, probably of greater concern, it also means the project should not be too complex, both in terms of time and statistical content. The statistical aspects of the project should be limited as much as possible to the material we will be covering in class. As a rough guideline, I would think that a stand-alone project might require from 30 to 40 hours including planning, carrying out the study, analysis and write-up. Probably it is fair to say that my expectations will be a bit higher for projects involving 2 or 3 students compared to those completed by a single student. For those of you interested in projects tied to other activities, this range of time might refer to the statistical portion of the total effort.

2. I would like projects to have a major component that requires **planning** the study and **collecting data** if at all possible. I recognize that that this might not be possible for everyone. In some cases the project that makes the most sense to you is one in which the data have already been collected. For those projects for which the data have previously been collected, I will expect a detailed critique of the study design and specific recommendations for future data collection for similar studies.

I am quite open to the type of project that is to be undertaken. For example, you could choose to conduct an experiment with fast plants (see www.fastplants.org), an observational study on animals, a laboratory study on some process that is subject to variability, etc. If you are involved in a research experience in a lab, the project could be tied with this experience. I am hopeful that this project could be tied together with work in another class. I will expect to have contact with you while you are developing your study to ensure that it is of the correct scope and I will be happy to provide feedback at any point in the process.

Since you will likely need to use at least some of the statistical ideas that will not be covered until later in the course, I would guess that most of your work on the project will be done in the last third of the semester. The due date for the project write-up will be Friday **April 28**.

I will also ask for a written **proposal** (typically 2 to 4 pages) to be handed in on of before Friday **March 31**st, four weeks before the final report is due. In this proposal, you will state in some detail what you intend to do in terms of experiments, analysis, etc. It is necessary that I approve the proposal. I will return written comments as quickly as possible and, if it seems advisable, ask you to meet with me to discuss them. It is also possible that I will ask you to rewrite the proposal. For those of you who anticipate the need for more than 4 weeks to carry out the study (i.e. growing plants), I encourage you to submit your proposal earlier than March 31st, which is the final deadline for handing in the proposal.

I will be pleased to talk with you about the project at any time. I am here to help you learn and make this as valuable an experience as possible. I strongly encourage all of you wishing to do a project to touch bases with me well before Feb. 21st (deadline for signing up) to ensure that you and I both feel comfortable that your idea is of the right scope. Do not hesitate to ask questions or put forth your own ideas. I am far more interested in finding ways to make optional projects possible than to put impediments in the way of your ideas!

2 Expectations for proposal and final report

2.1 Proposal

The proposal for the optional project is due on or before March 31st. The sooner you hand in your proposal, the sooner I will get you feedback, and the sooner you can "get to work". The primary purpose of the proposal is for you to explain in some detail what you intend to do on your project so that I can give you feedback to ensure that the project is of the right scope, and also provide suggestions if any seem immediately appropriate. I will always be happy to meet with you to discuss your project.

Thus, the bottom line for the proposal is for you to explain your intended project in enough detail so that I can fully evaluate it. Below I provide some guidelines for the proposal, but you should feel free to deviate from these guidelines if you feel that another approach will be more useful for your explanations. I would think that the proposal should be at least 2 pages long, and hopefully no longer than 4 pages.

Guidelines:

1. Provide a brief scientific **overview** of the problem. Basically, indicate what scientific issue you hope to address and, where possible, specific objectives of the project.

2. (a) If you will be collecting your own data, indicate in some detail how you will be collecting them. Discuss issues like sample size, experimental design, and how you will randomize. Hopefully, your explanations will be clear enough so that someone else could gather the data using your plan. It will be the most important part of your proposal.

   (b) If you have already collected your data, indicate in some detail how this was done. Discuss similar issues as suggested in part (a). However, this will not be the most important part of your proposal.

3. (a) If you will be collecting your own data, indicate your initial ideas for analyzing them. For example, if you will be testing hypotheses, what are the hypotheses? To the extent that it is possible, try to anticipate what types of analyses you might use. In general, the simplest analysis that answers a question is the best one to use.

(b) If you have already collected your data, provide your ideas for their analysis. It will be expected that you have given this some meaningful thought. Inclusion of some exploratory analyses might be appropriate. If you will be testing hypotheses, indicate what these hypotheses will be. Again, to the extent that it is possible, try to anticipate what types of analyses you might use. If the amount of data you have already collected is excessive and/or proper statistical analysis will require techniques beyond those we will cover in this course, you will need to limit the scope of the project. This may mean using only part of the data and/or answering only some of the questions you have of the data. In making any decision on scope limitation, keep in mind the statistical tools that will be available to you. These include primarily the topics listed in the syllabus.

2.2 Final report

The final report for the optional project is due April 28. Here I present some guidelines for the form of this report. Please note that these are guidelines and if some other organizational approach seems particularly suited to your project, do not hesitate to use it. Roughly, I would expect the report to be in the range of 10 to 15 pages in length including principal figures and tables. Additional material, such as the raw data, could be included in an appendix.

In general, the target audience should be viewed as someone who is knowledgeable in the scientific field appropriate to your subject and who has meaningful background in statistics. Thus, for example, you do not need to explain how a t-test works. However, you need to provide sufficient information so that it is very clear exactly what you have done, so that a reader could gather similar data and perform similar analyses.

Guidelines:

The first page should be an "executive summary", one page maximum. This should include in roughly equal proportions: a brief discussion of the scientific issue under consideration, how the data were collected and the specific findings of the study. You will probably wish to write this summary after you have completed the rest of the paper. In writing this section, put yourself in the following position. Suppose that a reader has read the full report several months earlier but wishes to review the key points on a later reading. The executive summary should serve that purpose.

Here are some possible section headings, in a suggested order (remember, these are suggestions only). If you structure your report differently, the same general information suggested below should be provided. Tables, figures, equations and computer output should be integrated into the text, so that, for example, a figure useful in a given discussion appears on the same page as the discussion. It will be fine to "cut and paste", or write equations by hand.

1. Scientific overview of the problem.

2. Material and methods. Here you need to provide information about exactly how the data were collected (this includes the experimental design) and how the data were analyzed. Results of the analyses are **not** provided here.

3. Exploratory data analysis. Here you might describe some of the general patterns in the data, including issues related to expected results, strange results or outliers.

4. Formal data analyses. Here you provide the formal inference including an interpretation of the results.

5. Scientific conclusions. Here you provide in broad terms the scientific findings that relate to the overview in Section 1.

6. Self-evaluation of your study and design. Here you should answer the following question. If someone else were to conduct a very similar study, what, specifically, would you suggest to him/her regarding the design of the study and the way data were collected? In some sense, this asks what you have learned about design and data collection from your analysis. For those of you doing projects on previously collected data, you should pay special attention to this section. In some cases, I recognize that the study was performed on data that were convenient. In such cases, perhaps you can use what you have learned to suggest additional data that might have been useful, or other practical ways of obtaining additional information that would help understanding.

3 Key dates

Feb. 21	Commitment deadline
March 31	Proposal deadline
April 28	Final report deadline.