Bighorn Sheep Rams at Bison Range National Wildlife Refuge
INTRODUCTION

The purpose of this course is to give you practice in the four broad areas required to be an ecologist: 1) natural history and observational skills; 2) use of the scientific method to make and test hypotheses; 3) some quantitative and statistical methods used to evaluate ecological data; and 3) oral and written communication skills.

Thus, these ecology labs will be an idiosyncratic mix of natural history observation, scientific method, hypothesis testing, experimental design, and statistical analyses appropriate for ecological data. A major goal of this class will be for you to gain experience communicating your results, both in written and in oral formats. The class constitutes 2/3 of an upper level writing (W) class, with a substantial part of your grade based on your written work. You will have the option to revise and resubmit some material to improve your writing. One lab report and your independent research project will be written in the form of manuscripts for Ecology, a major scientific journal. In addition, your research group will present a 15-minute, conference-style talk to the class on your research project.

GRADING SCHEME

Your grade will be calculated from the following:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
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<tr>
<td>Individual lab write ups</td>
<td>60</td>
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<tr>
<td>Group project</td>
<td></td>
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<tr>
<td>Project proposal</td>
<td>5</td>
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<td>Literature search</td>
<td>5</td>
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<tr>
<td>Oral presentation</td>
<td>15</td>
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<tr>
<td>Written report</td>
<td>15</td>
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<td><strong>Total</strong></td>
<td><strong>100</strong></td>
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TENTATIVE LAB SCHEDULE (may change because of fire closures/weather)

<table>
<thead>
<tr>
<th>Week of</th>
<th>Lab Activity</th>
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<tbody>
<tr>
<td>8 September</td>
<td>Introduction to Ecology Lab</td>
</tr>
<tr>
<td>15 September</td>
<td>Plant Distributions on Mount Jumbo</td>
</tr>
<tr>
<td>22 September</td>
<td>Independent project ideas; Literature Searching Methods</td>
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<tr>
<td>29 September</td>
<td>TBA</td>
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<tr>
<td>6 October</td>
<td>TBA</td>
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<tr>
<td>13 October</td>
<td>Big Horn Sheep Lab</td>
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<td><strong>Note:</strong> For this lab we will be hiking over hill and dale at the National Bison Range. Bring sturdy hiking boots, a backpack, suitable clothing, water, and snacks. We may not return until 7 PM, so please make arrangements for this ahead of time.</td>
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<tr>
<td>20 October</td>
<td>TBA</td>
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<tr>
<td>27 October</td>
<td>Greenough Park – Norway maple lab</td>
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<tr>
<td>3 Nov</td>
<td>No lab – time for your independent research projects</td>
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<tr>
<td>10 Nov</td>
<td>Information on preparing your oral presentation; help with your analysis</td>
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GROUP PROJECTS

Forty percent of your grade will be based on an independent research project that you do with a team of two or three other students. Think of the group project as an ecology lab that you invent. The purpose of this independent project is to give you a chance to be involved in all stages of a small scientific investigation, from the identification of an interesting ecological pattern or question, formulation of hypotheses that might account for the observed patterns, appropriate experimental design, collection, analysis and interpretation of the data.

Possible Research Questions

You will initially be tempted to carve out too big a project. A good project will consist of ONE carefully defined and delimited question, a set of hypotheses that might explain this pattern, and appropriate data collected to evaluate your hypotheses. One way of coming up with a project is to think of questions that you might have had while we were doing other labs. I suggest that you try and pick something fairly near Missoula. Also, stick with a project for which your group has appropriate natural history expertise. For example, do not look at habitat preferences of small mammals if no one in your group can tell the difference between a deer mouse and a grizzly bear. Check with us when you have settled on a possible topic. Also let me know if you need equipment for your project. To help you get started, I have listed below some ideas that would be appropriate:

1) Associations between some plants and rock slides on Mount Sentinel. Some plants on Mount Sentinel seem to be found almost exclusively near rock slides. Is this association real? If it is, what may cause the association?

2) Squirrels. There are many Fox Squirrels on campus. Is the placement of Fox Squirrel nest random with respect to tree species? Height? Exposure in the tree? How do Fox Squirrels store food? What spatial arrangement do they seem to be using when caching the food? Is there any pattern to the order in which they retrieve cached food? Do squirrels steal each other’s caches? If yes, how do they do it? If no, why don't they do it? What cues do squirrels use to retrieve their caches (e.g. smell, vision, memory, etc.)? Are the activity patterns of squirrels influenced by weather? Human and dog activity? You could modify many of these questions for Pine Squirrels that are common in Pattee Canyon. THERE ARE MANY PROJECTS IN HERE!

3) Species distribution and abundance in clear cuts versus burns. Are clear cuts ecologically similar to burned forests? Pick a group of organisms (e.g. lichens, beetles under rocks, ground cover, etc.) and compare the patterns of diversity in clear cuts versus burned areas. Note: If you choose this topic, it is especially important that you talk to me about experimental design. For example, you will have to pair sampling areas so that they are similar in elevation, exposure, and time since the disturbance, etc.

4) Effect of slope aspect on vegetation. How does the direction a hill is facing influence the plant composition?
5) Vegetation and beach lines on Mount Sentinel. There are repeating vegetation patterns associated with the Pleistocene beach lines on Mount Sentinel. However, the reasons for these patterns are poorly understood. You could take more measurements (e.g. soil temperatures or humidities over the course of a day) to further evaluate some of the outstanding hypotheses.

6) Knapweed Parasitism. Several different species of Tephritid flies have been released to control spotted knapweed. It is easy to find the maggots of these flies in the seed heads of the knapweed. Does the presence of a maggot influence the number of seeds produced? Can you detect density dependence in the rates of parasitism (i.e. are there more maggots in dense clumps of Knapweed than in sparse areas)? Based on your data, do you think these species might realistically afford a viable method of biocontrol?

7) Ant foraging and ecology. One local species of ant (Formica rufa) builds a very prominent mound nest. How far from the nest do these ants forage? What do they forage on? What quantity of food does a nest harvest a day? What might be the ecological impact of these ants on the surrounding vegetation? How does weather influence the activity patterns of the ants? What is the function of the mound? THERE ARE MANY PROJECTS IN HERE! DON'T ATTEMPT ALL OF THIS.

These are just a few ideas to give you some ideas about the sorts of questions that would be reasonable. However, we ENCOURAGE you to come up with your own research ideas. This is a chance to use your imagination and investigate something that excites you.

Miscellaneous
NO projects involving trapping of small mammals (risk of hanta virus).
Projects on vertebrates require permission from the University Animal Care Committee.

Group Presentation
During the week of 17 November, your group will give an oral presentation of your project to the lab class. These presentations will be in the format of 15-minute long conference talks (powerpoint presentation). You will be provided more information nearer to the presentations.

Group Independent Project
Working well in groups is an essential and important skill that will probably be very important after you graduate. If your group works well together, this can be an incredibly rewarding experience. If your group is dysfunctional, this is incredibly frustrating. The major source of friction usually occurs when some members of a group do not pull their weight. Don’t be a parasite!! As a group you will need to negotiate how to make sure that everyone is participating fully in the project. If you have problems with this that you are having difficulty resolving, please communicate with your TA.

The final report for your group independent research project is due during your lab period during the last week of classes (1 December). On your final project, all members of your group must sign the following statement: "We agree that the following members have contributed equally in the preparation of this report: followed by signatures of group members" Do not sign this statement if you do not agree with it.
FORMAT FOR THE FINAL PROJECT REPORT
These reports will be in standard format for publication in the scientific journal *Ecology*. To help you get started, there is a copy of a short article from *Ecology* following this section. Here are some guidelines about the required format.

**Title** This should be short but descriptive. To be maximally useful, the title should contain the following three elements: i) the name of the organism (or organisms, community, ecosystem, etc.) that were studied; ii) the particular aspect of the system that was studied; and iii) the variables) that were manipulated. For example: The Effect of Photoperiod on Migratory Behavior of Monarch Butterflies (* Danaus plexipus*).

**Abstract** The abstract is a one or two paragraph summary of the entire laboratory. Someone should be able to understand the abstract without referring to the rest of the laboratory. It should contain these four elements: i) the purpose of the study; ii) a brief statement of what was done (Methods); iii) a brief statement of what was found (Results); and iv) brief conclusions.

**Introduction:** The function of the introduction is to present the purpose of the lab, and place it in the context of what is already known about the topic. Before you introduce the particular details of your study, you must discuss the larger "big picture." If appropriate, you should describe the hypotheses you are evaluating. You should also include any background information about the species or experiment that is necessary to understand the lab.

**Materials and Methods** You must describe what you did and how you did it. This section must contain enough detail that someone else could replicate your experiments or observations. In cases where it is appropriate, describe the experimental design of your experiment or observations.

**Results** The function of this section is to report your observations and data without interpretation. Someone who has not seen your graphs and tables should understand the text. Incorrect: "The results are in Figure I." Correct: "The number of species of plants was significantly lower on site A than on site B (Figure 1)." Tables and figures are numbered and labeled with a description of what is being shown. You can include class data in cases where it is appropriate. Statistical tests are reported in this section, although conclusions about your original hypotheses are saved for the Discussion section. Graphs, charts, or tables can be used to summarize your results, but they may not substitute for a verbal summary of the findings.

**Discussion** The function of this section is to evaluate your results in terms of the original question or hypothesis. Do not simply summarize or repeat the previous statements you made in the results section. Draw conclusions based on your experiments, and relate your results to the general body of information on the subject. It is important that you discuss ALL of your results, including those that are unexpected or inconsistent with your expectations. In this section, you should also discuss possible source of error and potential biases in the experimental design. Since good science always leads to more questions, you should outline some of the questions that are raised by your lab.

**Literature Cited** In the text of your lab, you can refer to other research by including the author(s) name and date of publication in parentheses. For example: "Because the songs of most song birds have both a genetic and a learned component (Canary 1989), I expected . . ." If you
cite more than one study, it is conventional to list them in chronological order: "Because the songs of most song birds have both a genetic and a learned component (Tweety-Bird 1965, Canary 1989, Wren 1993), I expected ..." In the Literature Cited section, references are listed in alphabetical order using the following format:

**Journal Article**

**Book**

**Article in a book**

**Late Policy**
Without an authorized extension, labs will lose 10% per day that they are late.

**Plagiarism Policy**
Although we encourage you to work collaboratively with others in this class, the work you hand in must be your own. A good rule of thumb is that you can work together up to the point of committing words to paper (or word processor). After that, you must work independently. I remind you of the official University policy on plagiarism: "Plagiarism is the representing of another's work as one's own. It is a particularly intolerable offense in the academic community and is strictly forbidden. Students who plagiarize may fail the course and may be remanded to Academic Court for possible suspension or expulsion (See Student Conduct Code section of this catalog). Students must always be very careful to acknowledge any kind of borrowing that is included in their work. This means not only borrowed wording but also ideas. Acknowledgment of whatever is not one's own original work is the proper and honest use of sources. Failure to acknowledge whatever is not one's own original work is plagiarism." (From The University of Montana Catalog).

If you have any questions about the line between collaboration and plagiarism, see your TA before you hand in material. Assignments from two or more students that have significant overlap will be regarded as reflecting a violation of the expectation that students turn in independent work. All the students involved will be given no points for that material, and the violation will be dealt with according to the Student Conduct Code. Penalties may be as severe as suspension or expulsion from The University. For more information refer to the UM Student Conduct Code.

The exception to this is your Group Research Project. You will write this collaboratively, and hand in ONE written report coauthored by all members of your group.

**Change of Grading Option**
University policies on drops, adds, changes of grade option, or change to audit status will be enforced in this class.
16 September: Last day to add/drop classes. W appears on your transcript.
7 October: After this date classes can only be dropped by petition to the Dean’s office, and petitions are not automatically approved. The petition must be accompanied by documentation of extenuating circumstances that are spelled out in the UM catalog (illness, death in the family, etc.). Note that requests to drop a course or change the grade basis to benefit your GPA will not be approved. WP (Withdrawn passing) or WF (Withdrawn Failing) appears on your transcript.

Computing Resources
The Division of Biological Sciences manages a computer lab that is dedicated to use by biology students. You need to sign up for an account, and this will enable you to have access to the computer hardware and software, and printers. To get your account, go to Health Sciences 114 between 8 AM and 5 PM and a lab monitor will help you.

MISCELLANEOUS
1) Lab reports must be typed.
2) Lab reports must be stapled.
3) Scientific names are underlined or italicized.
4) There is a difference between an observation and an experiment. Observations involve collecting data or describing nature without manipulating any factor. Experiments involve manipulating one or more variables (e.g. temperature or pH) while holding everything else constant. Some of these labs will consist of observations only; others will involve experiments.
5) Take pride in your writing. Although scientific writing is different from other forms of written communication, you are still conveying information using the English language. Good scientific writing is concise, precise and as simple as needed to convey the information. Use technical terms when they clarify your point; avoid them when they do not. You will be graded on your English. See the next two pages for "Nineteen Rules For Riting Some Good," and "How To Rite Official@."
6) Do not be discouraged by "null results," such as experiments that did not work out as planned. Welcome to SCIENCE! There is no "right" answer for every lab. Your task is simply to draw conclusions based on your results. You can get full marks for a well-written report in which "nothing happened." Conversely, you can get a poor grade for a poorly written lab report in which "everything happened."
7) Above all, have fun and enjoy the study of the amazing world around us!

Digression on Writing
Take pride in your writing. You will be graded on your writing in this course. Although scientific writing is different from other forms of written communication, you are still conveying information using the English language. Good scientific writing is concise, precise and as simple as needed to convey the information. Use technical terms when they clarify your point; avoid them when they do not.

If you would like help on writing, The University of Montana has an excellent Writing Center. This is a very valuable resource, and you can get free tutoring. You can get more information at:

The Writing Center. LA 144 and Mansfield Library; 243-2266; growl@mso.umt.edu
Some of the best advice on writing for biologists was compiled by the ecologist Herbert Andrewartha in his book *Introduction to the Study of Animal Populations* (1961, University of Chicago Press). Some of these insights are summarized below:

Orwell’s (1946) five rules are a useful guide for scientists. I repeat them below, not quite literally.

1) Never use a long word where a short one will do.
2) If it is possible to cut out a word always cut it out.
3) Never use the passive where you can use the active.
4) Use technical words sparingly and correctly; never use a word that cannot be understood by a scientist working in a related field.
5) Break any of these rules rather that say anything barbarous.

**On the “adjectification” of nouns – avoid strings of nouns (after Leeper 1941, 1942).**

Once the first downward step is taken and the abstract noun is accepted as the pivot-word of the sentence, the second step is easy. This is the use of sets of two or more nouns, only the last of which has the full status as a noun, while the preceding nouns qualify it. The double noun, of course, is part of our language. Some double nouns, like *boatrace* and *newspaper*, have even been accepted as single words, while many others are commonly used without offence, like *vapour pressure* and *spot test*. But a writer of any sensibility will use them sparingly, and will avoid double nouns which are not in every day speech, such as the ugly *fertility decline* or *phosphate source*.

Dunsany made a satirical remark that we may use the frequency of multiple nouns in a given passage for dating our *language decay progress*. A treble noun like this is always inexcusable, yet treble or even quadruple nouns are common in our journals. The vice of this habit is not that experts think it is ugly, but simply that it makes reading difficult. We do not know at first whether we are reading about *language, decay, or progress*, and we must waste some seconds in reading the sentence over in order to solve the puzzle.
TWENTY RULES FOR RITING SOME GOOD.
(Twenty of the Commonest Writing Mistakes)

1) Avoid run-on sentences you have to punctuate them in the middle.

2) Verbs has to agree with their subjects.

3) Don't use a preposition to end a sentence with.

4) Check to see if you any words out.

5) Don't abbrev.

6) About sentence fragments.

7) When dangling, don't use participles.

8) A writer must not shift your point of view.

9) Do not use no double negatives.

10) Watch out for irregular verbs which has cropped up.

11) In my opinion I think that an author should not get in the habit of making use of too many unnecessary words that are not really needed since the same thing can probably be said just as well more succinctly with fewer words and it will probably make the point more forcefully anyway.

12) Just between you and I, case is important.

13) Its' important to use apostrophe's correctly.

14) Do not use commas, which are not necessary.

15) In letters essays reports articles and book reports use commas to keep a string of items separated.

16) Each pronoun agrees with their antecedent.

17) Join clauses good, like a conjunction should.

18) Chek yer spelin.

19) Always finish what you

20) Last but not least, lay off clichés.
HOW TO RITE OFFICIALESE®
(You DO NOT want to write OFFICIALESE unless you aspire to a political office or plan to write computer manuals)

1) **Start with a simple statement.**
   We quit. Nobody knew how to program the computer.

2) **Put it in the passive voice and dilute the responsibility.**
   It was decided to quit.

3) **Replace simple but accurate words with longer, vaguer words.**
   It was decided to terminate.

4) **Build in noun strings.**
   It was decided to terminate project processes.

5) **Add a qualifier of uncertain relation to the original statement.**
   On account of the status of the computer, it was decided to terminate project processes.

6) **Add more noun strings and more terminology to the qualifier.**
   On account of the status of the computer program assessment planning development effort, it was decided to terminate project processes.

7) **Separate related words.**
   On account of the status of the computer program assessment planning development effort, it was decided to terminate until a later date project processes.

8) **Equivocate and Obfuscate.**
   On account of the uncertain status of the computer program assessment planning development effort, it was proposed and tentatively accepted to terminate until a later date project processes.

9) **Cover your tracks to make yourself look good.**
   On account of the unavoidable uncertainties in the status of the computer program assessment planning development effort, a number of contingency proposals were carefully considered and one was tentatively adopted to suspend on a temporary basis until a later date those project process deemed unessential to the expeditious fulfillment of contract requirements.

Voila!