BES 316 Spring 2010

**HERBIVORY**

Goals for This Lab Exercise

1. To practice the art of developing and carrying out a complete ecological research project
2. To understand equipment applications & limitations
3. To practice collecting microclimate data

**SCHEDULE for MAY 27, 2010**

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| **Time Period** | **Activity** |
| 8:45 – 9:30 | Preliminary observations of herbivory (campus wetlands as a whole class) |
| 9:30 – 12:00 | Group time to develop questions & methods |
| 12:00 – 1:05 | Groups meet with instructor to discuss project design |

**HERBIVORY**

A consumer-resource biological interaction is an instance where one organism benefits and the other is negatively affected. Herbivory is considered a type of consumer-resource interaction where the negatively-affected organism is not killed. When animals are consumed they are usually killed and thus the interaction is considered as predation, rather than herbivory. The consumption of plant material often does not result in the death of the plant, meeting the definition of herbivory. One prominent exception is the consumption of seeds, where seeds are viewed as organisms. Seed consumption is often termed, “seed predation”.

Herbivores can take many forms, from insects to large mammals. The importance of herbivory in plant communities varies from situation to situation. In the 1960s some scientists began to address the question of “why is the world green?”. They posited that herbivores must be limited by factors other than their food supply (plants) or else they would be usually consuming most of the plant material in ecosystems. As the world is green in many locations (i.e., there are plenty of plants around), they proposed that the populations of herbivores are often controlled by predators (a “top-down trophic control). This has been known as the “green world hypothesis”. While top-down control is indeed evident in some cases, there are other instances in which herbivores are controlled by abiotic environmental factors, such as extreme temperatures, water availability, etc. Furthermore there are clear instances where the population of herbivores is indeed limited by their food supply and they therefore have an overwhelming impact on plant communities. Insect outbreaks and intense grazing by herds of large mammals are clear examples of that.

The effect of herbivory on plant species diversity is similarly situation-specific. In many instances, intermediate levels of herbivory are associated with the highest levels of diversity. Intense herbivory excludes many species not highly tolerant of such impacts, while very low levels of herbivory allow highly competitive plant species to exclude other species through competition. Moderate levels of herbivory serve to suppress superior competitors, maximizing plant species diversity. However, such patterns are not always observed and the overall effect of herbivory on plant diversity is complicated by other biotic and abiotic environmental conditions.

Plants have adapted to herbivory in a number of creative ways. Defensive investments are common where herbivores are abundant and leaves are long-lived. Leaves with longer life spans will be more likely to be encountered by an herbivore and consumed during their lifetime and thus plants have responded by investing to defend such structures. There are a number of chemical defenses employed which can distrupt herbivore digestion, reder the material unpalatable, or even act as toxic to the consumer. Some plants exude sticky resins to physically disable insect herbivores. There is even evidence for chemical communication among plants to deter herbivores. Certain hardwood tree species in the eastern US will emit ethylene upon insect attack, and surrounding trees respond to the ethylene by increasing production of anti-herbivore chemicals in their leaves. Physical adaptations are common as well, including spines, building structurally-tough leaves, and even incorporating crystals in the foliage material that can tear the gut-track walls of insect herbivores. Finally, some plants have evolved mutualisms for defense against herbivores. Acacia trees commonly induce ant colonies to live on or near them by providing lipid substances for the ants, while the ants vigorously defend the tree against attacks by herbivores.

In addition to adaptations to deter herbivory, many plant species have adapted to simply respond to herbivory. Many plant species possess growing point (buds) that are protected from herbivores and use tehse to regrow plant material following herbivory. Grasses often maintain their central growing point (apical meristem) at or near the ground surface where it is protected from grazers. Once the aboveground foliage is removed, the meristem simply grows more material to replace the foliage eaten. Some woody species maintain epicormic buds along the stem, or near the base of the central stem, which are released upon removal of the central apical meristem (Pacific willow is a good example of this in our wetland). In such cases, herbivory has a strong affect on modifying the canopy of the the plants.

This exercise is designed as a culminating project for BES 316. The previous exercises were scientific studies in which the questions and methods were provided. However, the most challenging part of research is often the derivation of good questions and the design of appropriate methods. This project starts with your own observations on herbivory in the campus wetlands and moves from there to the identification of a research question. You will design and carry out an ecological research study around this question, followed by analyses and presentation similar to those that you have practiced throughout the earlier weeks of this course.

**CARRYING OUT THE EXERCISE**

You will carry out this exercise as an instructor-assigned group of 2 or 3 students. My intention is that you will design an ecological research study that can be carried out with observations over the course of one or two trips into the campus wetland (of anywhere from 2 – 4 hours in length).

**May 27:**

Today we will spend about 45 minutes in the campus wetland making observations of herbivory as a whole class. This is meant to be a collaborative jump start to your observations and project development.

You will then break apart into your assigned study groups. Each group will have 2.5 hours to make more observations, formulate a central research question, and create a general study design for discussion.

During the last hour of class, each of the three research teams will meet with me (in the classroom) for 20 minutes to describe their prospective study and research design. If your project looks good I will give you permission to proceed directly to undertaking your investigation. If your project needs further clarification or revision, I will require you to undertake such revisions and meet with me during class time on June 1 to discuss these before beginning your study.

**May 27 – June 7:**

No class will be held on June 1 and June 3 to allow class time for your data collection and analysis. You are not restricted to doing this only during class time (and will likely need time outside of class to complete your work in a timely fashion).

**June 8:**

Your study will be carried out as a group. Originally (on the course syllabus) I had indicated that your group would submit a poster on your study on June 8. However, on further reflection, I do not feel there is sufficient time for you to accomplish both a poster and a paper. Thus, I will omit the poster requirement. You are required to prepare an individual written report on June 8 (the first Tuesday of finals week) – by the end of the day (5 PM). Your written report must be submitted in both electronic and hardcopy formats. The written report will be worth 40 points.

**PRODUCTS**

**Written Report**

You may summarize the individual data measurements as a group, but any calculations, analysis, and illustrations should be done strictly on an individual basis.

Your written report should take the form of a scientific research paper. You should be familiar with the details of this from BES 301. It should be written for a general audience of fellow scientists (not necessarily ecologists) who may or may not be from this area. Literature citations should follow a name-date CSE format. You are required to use 1-inch margins and 12-point fonts.

This report should include the following sections (titled as shown except for numbers 1 and 2):

**(1) Title of research project**

**(2) Author**

**(3) Introduction**

This section should introduce the topic of the research study. You are required to read and use (cite) **at least two** relevant scientific papers (original, peer-reviewed reports) as background. I am not expecting a thorough literature review, rather just evidence that you have investigated and thought about the significance of some other studies to your project. Be sure to include information on the central research question(s) and hypotheses being tested. It is best to include this as an explicit subsection of the Introduction.

**(4) Study Location**

Briefly describe the study location you used and why it was appropriate for the question being addressed (may include a map and/or photographs).

**(5) Methods**

Describe the overall study design and the approaches used to conduct the research in the format of a Methods section of a published research paper.

**(5) Results**

Present your data as it would appear in a Results section of an original research paper (including both text and illustrations: photos, maps, tables and / or graphs). All illustrations should have complete captions and should be referenced parenthetically in the body of the text (as one encounters in a scientific paper). You should refer back to material from BES 301 to be sure you are doing this correctly.

**(6) Discussion**

This section focuses on interpretations and conclusions as would be found in a Discussion section of a research paper. You may use the relevant literature that you reviewed in the Introduction section to help you place the significance of your results into context. However, I am not expecting a major integration of your study results with published literature. I will place most of the emphasis in this section on a thoughtful interpretation of your results that is clearly and validly based upon the quantitative analyses.

**(7) Literature cited**

I expect these to be presented in CSE format.

There are no explicit page requirements, but in general I expect that your report will be about 5 - 10 pages in length not including the illustrations (tables and graphs). This may vary depending upon the project. I am more interested in a complete, well-presented report and thoughtful analysis than any specific number of pages. The emphasis in grading will be on your analysis, but presentation will also be a significant factor. It should be well written, with close attention paid to clarity of writing and brevity (but not at the expense of completeness).