Ecosystem Ecology Lab

The lab portion of the course will consist of a class effort to contribute to an energy model for a local ecosystem (Grandview Nature Preserve) and exercises to introduce several techniques common to ecosystem energy studies and ecosystem studies in general. The class will determine certain elements of the budget (working in groups of 2-4 students each). The budget and model will focus on a transect from dune to marsh. Exposure to NSF's Long Term Ecological Research (LTER) Program will be obtained through class discussions of the literature and a field trip to the Virginia Coast Reserve LTER site.

1. Site Visitation and Conceptual Model Formation

An initial visit to Grandview will be taken to become familiar with the site in order to form working groups and develop ideas for the model. Make notes on the major biotic and abiotic features of the system. In addition to the field observations, gather some basic information on the ecosystem type being studied from the literature, and develop a conceptual model (box-and-arrow diagram) of the system. This conceptual model will provide a framework for the class effort. On this trip, you will also collect plant material for the construction of litter decomposition bags (see below).

Initiation of litter decomposition measurements

a. Clip and bag some vegetation for litter bag construction, return to the lab, and air dry (do not oven-dry).

b. Weigh out 5-6 g of air dried plant material, place into each of 6 nylon litter bags (per site), sew up the ends of the bags, and place on the soil surface in the field next week (mark their location).

Oven dry (70 C for 48 hrs.) a subsample of the air-dried material (get an air dry weight first), weigh the oven-dried subsample, and calculate an oven dry weight-air dry weight conversion factor. The bags will be collected later in the semester and reweighed to estimate decomposition rates.

2. Plant Biomass Determinations

a. Locate 5-1/4 m^2 plots per site.

b. Within each plot, clip all aboveground vegetation, separate live from standing dead, place in separate paper bags and return to lab.

c. Scrape off all surface litter from each plot and place in paper bags.

d. Place litter bags into the field.

e. Oven-dry all samples at 70 C for 48 hours. Tare several oven dry bags, weigh sample bags, subtract tare weight.

f. Calculate means and standard errors and convert units to g/m^2.

3. Bomb Calorimetry

Operation of the Parr bomb oxygen calorimeter will be demonstrated. A handout of instructions for use of the instrument will be provided. Every student should gain experience with the Parr bomb. Students will determine the caloric content of plant and litter samples and appropriate materials collected in their group study. Data will be in kcal/g. Where appropriate, calculate energy standing crops for compartments on the site in kcal/m^2 by using the caloric values and biomass.

4. Group Projects

By the end of the second week of the semester, each group should have finalized the plans for their project. The class will measure the dominant biotic component of the system (plants) and key processes (production and decomposition) as prescribed in this lab handout. Selected other parts of the system are to be studied through the group projects. Other important (or potentially important) components include invertebrates, small mammals, belowground vegetation, etc. The project could involve a lab study such as a gravimetric measurement of energy flow for a small rodent.

Example: Energy budgets could be determined for small mammals trapped in the field. The animals would be maintained in metabolic chambers. For one week, feed the animals a known dry mass of food (lab chow), collect the feces (dry and weigh), and note any mass change in the animals. Bomb samples of food and feces to determine caloric content. Estimate ingestion, egestion, assimilation, production, and respiration (in short, develop an energy budget for the animal). Also calculate assimilation efficiencies. Assume: dry weight rodent tissue = 27% of fresh weight; caloric value for rodent tissue = 5.163 kcal/g-dry weight

5. Hog Island Field Trip and Determination of Free Surface Profiles

We will go on an all-day field trip to Hog Island, part of the Virginia Coast Reserve LTER site on the Delmarva Peninsula. The primary purpose of the trip is to experience first hand one of the LTER sites in the premier ecosystem study program in the world and learn about some of the on-going studies. We will also take soil cores and qualitatively examine the soil profile and water table features (one of the critical "free surfaces" that are a major focus on the site) across a dune chronosequence on north Hog.

6. Net Primary Production and Decomposition Rate Determinations

a. Carefully recover litter bags, gently rinse, oven dry, and weigh litter. Mass loss represents decomposition. Estimate rates as g g^{-1} day^{-1} and % mass loss.

b. Using the same techniques as before, harvest vegetation in 5-1/4 m^2 plots adjacent to the original plots, oven dry at 70 C, and weigh. Use the Wiegert-Evans technique (per instructions) to estimate net primary production for the period of study. If any one component of the model (change in live or change in dead) has a negative value, then treat it as zero. Compute for each set of paired plots and then average those values within a segment of the transect. Units should be g m^{-2} day^{-1} and kcal m^{-2} day^{-1}.

7. ModelMaker Orientation and Exercises with Silver Springs Model

You will learn to use ModelMaker to construct and analyze mathematical models of ecosystems. A sample model of Silver Springs Florida (handout to be provided) will be used to demonstrate the software, and you will perform manipulations of the model (to be assigned during the lab) to become more familiar with the application.

8. Grandview Model and Model Analyses

You will develop a mathematical model of the Grandview ecosystem based on the previously created conceptual model, data gathered by the class throughout the semester, and some literature values (with the instructor's assistance). You will also perform several simple analyses of the model (to be assigned in lab).