Optimal Foraging

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Focus: The students will learn to compare and statistically test hypotheses based on ecological models of optimal foraging

Overview: This lesson centers around the *marginal value theorem* (MVT, Charnov 1976), which describes how animals should forage in patches. The students will complete a lesson in R to practice using data they will collect directly as they 'forage' in an in-class lab. Specifically, they will practice creating vectors and tables of data to use in plotting and creating an ANOVA to compare high-, medium-, and low-density patches by their associated *giving-up time* (GUT) data. Students are then expected to repeat the coding steps they learned in R with example data to later test a hypothesis of their own.

Learning objectives:

1. Complete a prelab reading to familiarize themselves with the goals of the lesson and the background ecological information of optimal foraging
2. Practice coding elements necessary to create data frames, plot, and test MVT hypotheses based on the data
3. Apply the coding learned through swirl to their own hypothesis to answer whether different density patches lead to different GUTs

Lesson sequence:

1. Intro to optimal foraging (may be skipped if recently covered in class)
2. Lab handout (To show what is expected in lab once students arrive; may be skipped if using pre-generated datasets instead)
3. Swirl lesson
    a. Intro
    b. Vectors
    c. Data Tables
    d. Plots
    e. ANOVA
4. R code generation relative to student hypotheses

Pre-lesson activities: Prelab reading relative to the basic elements of optimal foraging, if students need a refresher (it will help make sense of the group comparisons by prey density in the latter part of the SWIRL lesson). This can be skipped if you have already (and recently) addressed this in your course. The goal is that students familiarize themselves with the general idea of optimal foraging and that they have code (and the associated rationale) to help them in collecting and comparing their own data.

Post-lesson activities: Students are to come to lab with their code saved to run comparisons on the data they derive. After data collection in lab, it is suggested that students submit their in-class worksheets and a 1-paragraph abstract of their experiment (including statistical test run, df, test statistic, and p-value), along with a figure addressing their hypothesis that is generated in R (although it need not follow the exact style of the figure generated in the swirl lesson).

Implementation notes: This lesson was designed to be done prior to a 3-hr laboratory where students actively collect data and repeat the coding steps using their data. However, rather than a pre-lab activity, one could first collect the data in class and run the coding steps piecemeal seeing first a small example and then running one's own data before moving on to the next step. For this reason, the lesson is subdivided into several subparts to facilitate students stopping and starting, as well as review of critical elements when students begin writing their own code. Encourage students to go slowly and keep a document open in which to paste the code (and any notes) as they work; it will make generating their own R code, plots, and statistics much easier. Additionally, this lesson uses some packages that can occasionally stall the program. If a student gets stuck, restarting R and/or installing the package and opening it before opening swirl generally fixes the problem. One aspect that seems to help is having students uniquely name their datasets and variables to clearly delineate and save example data separately from that which is derived in class.

Helpful References for Background and Suggested Lab Activities:

Charnov, E. L. 1976. Optimal foraging: the marginal value theorem. *Theoretical Population Biology* 9:129-136.

MacArthur, R. H., and E. R. Pianka. 1966. On optimal use of a patchy environment. *American Naturalist* 100:603-609.

Miller, T. E. 1999. Optimal foraging: Balancing costs and rewards in making foraging decisions. Pages 188-205, *in* Tested studies for laboratory teaching, Volume 20. (S. J. Karcher, Editor). Proceedings of the 20th Workshop/Conference of the Association for Biology Laboratory Education (ABLE), 399 pages.