

## **From Hypothesis to Manuscript: Small Group Research Projects in Ecology for Introductory Biology and Ecology Courses**

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This exercise, which runs over two 3-hour lab periods, is designed to stimulate creative and critical scientific thought in biology students. The emphasis is on process, not data. The exercise is preceded by a lecture on the scientific method, including such topics as hypothesis testing and experimental design. Students also have a 90-minute workshop on how to write a scientific paper and make an oral presentation.

In the first 40 minutes of the first 3-hour lab session, the students are told the purpose of the project, which includes getting them to ask ecological questions, carry out hands-on field work, and effectively communicate their results both orally and in writing. They are briefly introduced to the various ecosystems available for study (field, forest, pond, etc.) and the kinds of simple equipment available for the study (meter sticks, thermometers, sample jars, trowels, binoculars, waders, plankton nets, sweep nets, etc.).

To show the students what they will be doing in small groups, the instructor leads the lab group (consisting of 25–30 students) through a “brainstorming” session using an ecosystem not available to the students. The group writes down what they know about the system (point form) and then writes down what they would like to know about it. The group chooses a question, constructs a hypothesis, and makes one or more predictions based on the hypothesis.

Next, the lab group is organized into teams of four. Each team chooses an ecosystem and follows the same brainstorming procedure. For the next 60 minutes each team designs an experiment to test their hypothesis (the design includes a blank data table and sampling schedule). The instructor emphasizes that the study must be kept simple due to equipment and time limitations. It is important that the instructors do not provide ideas. The project belongs to the students and the instructors are present as a resource and to make sure what is being done is practical.

For the last half of the first 3-hour session, each team goes into the field to collect data. At the end of the 3 hours each team submits their question, hypothesis, experimental design, and data (worth 20% of grade). Evaluation is based on organization, clarity, and completeness.

In the first half of the second 3-hour session, the team meets to discuss their results. They examine possible methods of analysis, prepare rough graphs and tables summarizing their results, and draw conclusions. During the second half each team makes a brief presentation (5–10 minutes) (30% of grade) on their project including a statement of the hypothesis and a brief description of their methods, results, and conclusions. The rest of the class provides constructive feedback and questions.

The individual lab report (50%), submitted in the format of a scientific publication, is due 2 weeks after the oral presentation.

This exercise has been used successfully for several years with classes of up to 300 students, divided into lab groups of 24–30 students and then into five or six teams of four students.