Note: Dr. Harold Ornes is the editor of Ecology 101. Anyone wishing to contribute articles or reviews to this section should contact him at the Department of Biology and Geology, University of South Carolina–Aiken, 171 University Parkway, Aiken, SC 29801; fax: 803-641-3251; E-mail: whornes@univscvm.csd.scarolina.edu.

Dr. Wendy Roberts, Department of Integrative Biology and Museum of Vertebrate Zoology, University of California, Berkeley has found a useful technique to "break the ice" and at the same time serve as a good assessment tool in an introductory Ecology course. I think you will agree that using 3 x 5 cards to assess student learning on a given topic quickly can be an effective method to engage and assess students.

Harold Ornes

HOW MANY STUDENTS KNOW, HOW MANY SPECIES ARE ON EARTH?"

Teaching an ecology course for the first time, I was confronted with the quandary of how to introduce the course. I had just completed my Ph.D. in May of 1994, and the Department of Integrative Biology at the University of California at Berkeley hired me in August 1994 as a Lecturer to teach General Ecology. I asked an emeritus professor in the department, William Lidicker, for advice on material to include in the first week of class. He suggested that addressing how many species there are on earth was a good place to start, and he commented that many students had no idea of the number.

I designed an activity in which students would report their best estimates of species numbers. The first day of lecture I explained course logistics and presented an overview of topics to be covered in General Ecology. Then, as is common on our campus, I asked students to fill out a 3" x 5" card with basic information about themselves, their enrollment status, and why they were taking the course. Finally, I asked them to answer the following question: "How many species of plants and animals are there on earth?" I specified plants and animals so that the more sophisticated would not wonder if they need include organisms such as bacteria or viruses. I assured those who were wait-listed for the course that the accuracy of their estimate would not jeopardize their future enrollment!

After the lecture I summarized their estimates in a histogram (Fig. 1). At the lower end of species number estimates was the student who said "three that I can recall." While he may have been exercising his sense of humor, several students seriously estimated 100 species, making me suspect that "three" was a genuine guess. The histogram is roughly normal with a peak at one million, which is reassuring since it is getting close to the right ballpark. A large spike occurs at one billion, and several students wrote "billions and billions." In discussing this result with the class I suggested that perhaps they had watched too much of Carl Sagan on television at an early age. I told them in the future to remember that "billions and billions" refers to stars and not to species.

Anchoring the upper end of the estimates was one student who wrote "a trillion" and another who simply drew an infinity symbol. Out of 108 responses, 15 refused to answer the question, or gave vague responses that could not be quantified. These responses included statements such as, "It can never be known because extinction and evolution is happening all the time." I should emphasize that this course is for upper division students who have had an introductory biology course. Some are majors in our department, while most others

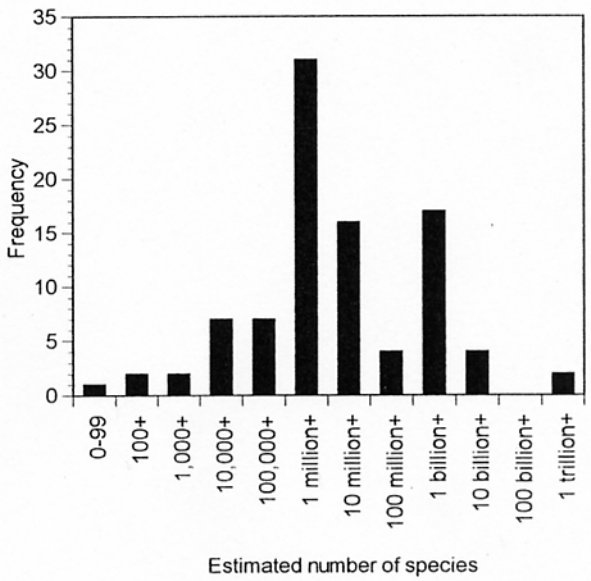

Fig. 1. Undergraduate estimates of the number of species of plants and animals on earth. The results shown here are from 93 students. The + indicates that the category includes all estimates up to the next order of magnitude. For example, 100+ includes all estimates between 100 and 999.

come from departments with an emphasis on environmental issues.

After describing the class estimate during the second lecture, I discussed species number estimates made by people I referred to as "having a little bit more experience as biologists." I gave the students handouts of estimated animal and plant numbers from the 1950s. I went on to describe more recent work and gave them a handout of May's (1986) paper, asking them to read it by the next lecture. May (1986) also gives a good brief review of the methods used by ecologists to estimate species numbers, and how these methods have changed.

I emphasized that they should not be concerned if their estimates were far off, that estimating species numbers is a difficult and contentious matter among ecologists. I pointed out that estimates of species numbers I had found in current ecology textbooks ranged from 1.5 to 300 million. I finished the lecture by discussing different ways of defining species, and giving examples of why ecologists should care about species definitions.

Several other activities could follow this exercise: (1) Ask students how they came up with their estimates, and identify any nonscientific thinking or "naive theories" (Fitcher 1988). (2) Ask them to re-estimate species number to see how a second histogram of student estimates would differ. This second estimate would be harder to quantify, since part of what the students have learned is the wide range over which species-number estimates vary. (3) Have students develop ways of testing their estimates and discuss sampling techniques, the value of estimation, and basic statistics such as mean and variation.

This exercise was informative about the state of student knowledge, and gave a good starting point to the course. Besides leading into a discussion of species numbers and species definitions, it allowed me to show that there is often not one correct answer to a seemingly simple question, and to show historical changes in opinion, demonstrate the processes ecologists use to form opinions, and to discuss an issue of current controversy and relevance.

Literature Cited

Fitcher, L. S. 1988. Teaching science to the liberal studies student. Journal of College Science Teaching, February 1988: 289-294.

May, R. M. 1986. How many species are there? Nature **324**:514-515.

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Section and Chapter News

AQUATIC ECOLOGY SECTION

The Aquatic Section would like to thank the students and faculty of the University of Tennessee for hosting the Annual ESA Meeting this past August. We also encourage submission of contributed papers by members of the section for the upcoming meeting at Snowbird, and for symposia for future meetings. The symposium deadline is generally in September of the year prior to the meeting. The Aquatic Section mixer and business meeting was well attended. Bob Naiman led a discussion of the current status of "The Freshwater Imperative: a research agenda for limnology" and plans for its implementation.

At the ESA Council Meetings, plans to restructure the governing board of ESA were the focus of most of the discussion. Key issues will be presented to the entire membership in future ESA mailings. At the second Council meeting, Dr. Judy Meyers assumed the position as the President of ESA from the outgoing President, Dr. Jerry Franklin.

This year, six graduate students received travel grants from the Aquatic Section to help defray costs of attending the meeting. To be eligible for the award for next year (of $75 to apply toward travel costs), the applicant must be a graduate student, a current member of the section, and must be presenting a paper or poster at the meeting. Persons wishing to apply for these grants should send their name, address, and a copy of their paper or poster abstract to: Carol Folt, Department of Biological Sciences, Dartmouth College, Hanover, NH 03755-3576. Applications will be accepted until 1 June 1995, and awards will be issued thereafter. In the event more applications are received than we can fund, selection will be by lottery. Please keep this in mind for the 1995 Annual Meeting in Snowbird, Utah.

Carol Folt, Chair
Aquatic Ecology Section