Simulating Population Growth

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Population growth is an important ecological concept for students to understand. Human population growth, resource limitation, and other population-related issues are easier for students to comprehend if they have a background in elementary population principles.

Students, of course, realize that populations grow but sometimes fail to grasp important implications of population growth. How quickly might a population be able to grow? How critical are resources to sustained population growth? Are all populations governed by the same ecological principles? To help students answer these questions, I allow them to experience exponential and logistic population growth in a very simple, interactive demonstration. I follow the demonstration with a discussion of the implications of population growth principles.

I bring enough tennis balls or bean bags or even balled-up sheets of paper (anything that students can safely throw and catch) so that each person in the class will have one. I select two students to come to the front of the room and I give each a ball. On my cue, each simultaneously throws his/her ball relatively high into the air and tries to catch it. Throwing and catching the ball represents the survival and reproduction for that "organism" for that generation. A student who drops the ball is considered dead and returns to his seat. [This is why I start with two students. Starting with just one student may lead to immediate population extinction if he/she is not successful!]

Surviving students pick a classmate to be their "offspring." Each offspring is also then given a ball. I record this new population size on the board. These students will attempt this and subsequent rounds of reproduction by simultaneously throwing and catching the ball of each on cue. (The students may ask if they may spread around the room to make this task easier—by all means permit this.) Even with a relatively large class, all of the students will be standing soon, since even "dead" organisms will quickly be resurrected to be the offspring of a survivor.

Once the students reach the maximal population size (all students are standing as survivors), they are asked to return to their seats and the data (the population number at each generation) are graphed. Then I restart the simulation with one condition: all members of the population must keep one foot inside a hula hoop that is laying flat on the floor. Once again, I record the population after every generation and cue the students to toss the balls simultaneously. Initially, it is easy for each student to throw and catch the ball, even with students crowded within the hula hoop. However, after two or three rounds of reproduction, "mortality" becomes higher. It simply becomes too crowded for all students to be successful, and the population size begins to stabilize. Several more rounds follow to show that the population size fluctuates but returns to a relatively consistent number (which we identify as the carrying capacity). Before we finish, I impose a "natural disaster" on the population, reducing it to one or two members. The students then observe how the population resumes rapid, exponential-like growth until the resource (the space) once again becomes too limiting for the growing population, and a carrying capacity is reached. Graphing the data allows students to see the carrying capacity more clearly.

The discussion that follows focuses on how the reduced space served as an environmentally imposed limitation on population growth. Other environmental limitations students typically identify are food, water, shelter, nesting sites, and predators. It is much easier for students to understand how finite resources restrict population growth after this simulation.

If an instructor so desires, this simulation may be modified to include other biological phenomena related to population growth as well. This simulation uses an "asexual reproduction" model, but students could work in teams of two (one person to throw the ball and the other to catch). This "sexual reproduction" model would allow students to see the fitness of both "parents" as an important component of increased reproduction and population. Additionally, natural selection could be incorporated by having some students use only one hand to throw and catch the ball while their classmates use both hands. This would likely demonstrate, through the differential success of the two populations (one versus two hands), the advantage of having a beneficial variation or trait in this environment.

Simple, interactive simulations are often useful ways to explore more complex biological concepts. It is possible to increase understanding of a myriad of related population issues by introducing some of the more fundamental concepts in this fashion.

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