CHAPTER 53
POPULATION ECOLOGY

I. Student misconceptions

1. Students who have difficulty with math may not fully understand the exponential and logistic models of population growth. Make sure students can define and explain the meaning and significance of all terms in these equations.

2. Many students do not recognize that any positive *r* term in the exponential growth model results in exponential growth. Some students think that *r* must be greater than 1.0 to produce exponential growth.

3. Students may have a simplistic understanding of the effects of limiting factors on population growth. They may think that all density-dependent factors are biotic and that all density-independent factors are abiotic. Some students may consider that all factors except the most abundant one limit population growth or that the most important limiting factor is the least abundant one.

II. Pre-test to identify student misconceptions prior to addressing the material covered in Chapter 53

1. Consider a population whose growth over a given time period can be described by the exponential growth model: $dN/dt = rN$. Identify each of the following statements as TRUE or FALSE.
   a. A population with an *r* of 0.1 will decrease over time. *False*
   b. A population with an *r* of 0 will have no births or deaths during the time period under consideration. *False*
   c. If *r* stays constant over a 10-year period, the population will increase by the same number of individuals per year during that period. *False*
   d. Any population with a positive value of *r* will grow exponentially. *True*

2. Consider a population whose growth can be described by the logistic growth model: $dN/dt = r_{max}N[(K - N)/K]$. Which of the following statements about this population are true?
   a. *K* is always constant.
   b. *The per capita rate of increase declines as N increases.*
   c. *Population growth is greatest when the population is approximately half the value of K.*
   d. *At low values of N, the logistic and exponential growth models predict similar population growth.*

III. How can instructors address and correct the misconceptions that students have about population ecology?

1. Make sure students understand that estimates of global carrying capacity for the human race depend not only on population size but also on resource use per capita.

2. Students recognize that living things are adapted to survive and reproduce in the environments in which they live. Point out an equally important concept: that the metabolic activities of living things also modify the environment. Some of these changes, such as increasing levels of oxygen and decreasing levels of carbon dioxide, have been very beneficial to the majority of living things. In a very real sense, life itself has created the world in which we live.

3. Stamp and Armstrong (2005) recommend the use of complex ecological stories to require students to confront their misconceptions and construct a sophisticated understanding of ecological principles. They describe a 5E teaching cycle (Engage, Explore, Explain, Elaborate, and Evaluate) based on a story about the Eastern deciduous forest. The story is presented to students in mini-lectures, with students responding to questions in think-pair-share, class discussions, and concept mapping.

   Stamp and Armstrong's two-part story includes the ecology of Lyme disease, masting (peaks of nut production), gypsy moths, introduced insect herbivores, frugivory, pit-and-mound topography, development of soils, and acid rain. Students deal with a large number of key concepts during the teaching cycle, including population growth cycles and models, interactions among trophic levels, life history traits, human impact on ecosystems, mutualism, nutrient cycling, succession, and ecosystem evolution. A detailed version of Stamp and Armstrong's Eastern deciduous forest story is posted at: http://ecomisconceptions.binghamton.edu/index.htm.

IV. Post-test to identify whether students have corrected their misconceptions

The town of Hamelin is infested with rats, and the townsfolk are reluctant to hire the Pied Piper to lead the rats away. Two proposals are brought before the town council. One group proposes to place traps throughout the town, claiming this will reduce the rat population by 50% within a month. The other group proposes a new bylaw that requires all townsfolk to purchase rat-proof garbage containers, claiming that this will reduce the rats' food source by 50%.

Draw and label the logistic growth curve. With reference to this curve, describe and explain what you predict will happen to the rats' per capita growth rate and the size of Hamelin's rat population over the next few years, following the implementation of each proposal.

Reference

Stamp, N., and M. Armstrong (2005). Ecology 101: Using the "power of story" to

overcome ecological misconceptions and build sophisticated understanding. *Bulletin of the Ecological Society of America, 86(3),* 177–183.