Investigating Population Growth

The "Avril Gulf Tuna Population Simulation" allows you to investigate what happens to the sustainability of a population of fish as various factors change. You will also determine how limiting factors affect population growth rates. With populations, a **limiting factor** is the factor that controls the growth of the population. For example, if a population of plants has plenty of sunlight, good soil, nutrients, and water but there is a herd of goats constantly grazing on the plants, the size of the population of plants is limited by the goats. The goats are the limiting factor in that scenario. Some factors are **density-dependent factors,** which means they vary according to how dense the population is. For example, a contagious disease is density-dependent because the number of organisms that become sick depends on how dense the population is and, therefore, how easily the disease is transmitted. Some factors are **density-independent factors**, such as seasons or severe weather, which affect organisms regardless of population density.

There are four stages to the simulation. The first three stages explore different factors that affect population growth rates. The fourth stage combines all the factors of the previous three stages. As you work through the simulation, carefully follow the instructions provided at each stage.

Procedure:

1. Work with your partner to follow the tutorial in the simulation to familiarize yourself with how the simulation works. Read each screen carefully and be sure you understand each part of the tutorial before moving to Stage 1 of the simulation.

2. In Stage 1, click on the "Show Normal Population Growth" box to see the graph of what happens to this population if reproduction, migration, and death rates are moderate.

3. Explore what happens to the population as you change the three variables. In your science notebook, record your observations of what happens to the sustainability of the population. What variable settings cause the population growth rate to increase? What settings cause it to decrease? What settings cause the population growth rate to stay steady? What are the limiting factors?

4. Scientific advisors to the fishery have determined that the population is sustainable at 60,000 fish. Use the simulation to determine what settings for the three variables maintain the population at 60,000 fish. Record the graph and the settings in your science notebook.

5. Scientific advisors have reexamined the population data for the Avril Gulf tuna and determined that the population is sustainable at 80,000 fish. With your partner, predict what settings would maintain the population at 80,000 fish. Write down your predictions in your science notebook, and then use the simulation to test your prediction. If necessary, change the settings as you run the simulation. Record the graph and the settings in your science notebook.

6. Move to Stage 2, and repeat Steps 3 through 5. Note that in Stage 2 you cannot control pollution or disease events, which will occur at random intervals.

7. Move to Stage 3, and repeat Steps 3 through 5.

8. Move to Stage 4. In this stage, all of the factors are combined. Predict what settings will allow for a maximum amount of fishing while maintaining the fish population (i.e., have a sustainable fishery). Repeat Steps 3 through 5, but incorporate the maximum amount of fishing possible.

9. With your partner discuss the following questions. Record your conclusions in your science notebook.
   a. How does each of the factors in the simulation affect the sustainability of the fish population?
   b. Which factors are density-dependent and which are density-independent?
   c. How does this simulation compare to the model you used in Activity 5, "Tragedy of the Commons"?
   d. How could a model, such as this simulation, help fisheries biologists make recommendations about setting fishing limits?