SCOPE, SEQUENCE, and COORDINATION

A National Curriculum Project for High School Science Education

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Student Materials

Learning Sequence Item:

956

Limiting Factors for Populations

March 1996
Adapted by: Beverly Ernzen and Duane Dawson

Contents

This micro-unit was adapted by **Beverly Ernzen** and **Duane Dawson** (Pleasant Valley H.S., Pleasant Valley, Iowa)

Student Sheet

Science as Inquiry

Bottled Bacteria

In this situation, your bacteria divide and double in number each minute. Each bean represents a bacterium. For each minute the bacteria divide add the appropriate number of beans to the jar. The jar respresents their world. Start with one bacterium and continue dividing the bacteria until they run out of space. When all the jars are filled, what will happen? After making a couple of divisions, predict the time at which your jar will be half full.

1. Create a data table to record the time and the number of bacteria each minute.

2. At what time did your group realize it was running out of space? What did you do to solve the problem?

3. At what time was your original jar half full?

4. In this activity, which factor limits the existence of the bacterial population?

5. What additional factors would affect the population size in real life?

6. Graph your data as the number of bacteria vs. time (minutes).

7. Compare the impact of early divisions to the last two divisions.

8. Today, the number of people in the world is increasing in a similiar fashion. What significance does this growth curve have for humans in the future?

Student Sheet

Science as Inquiry

Bears?

In this activity, you will explore how bears depend on their habitat. After completing the activity, answer the questions below.

1. Create a table that shows the number of pounds required in each food category and the number of pounds you collected as a bear. The table should also show the total number of pounds you collected and the amount of water secured.

2. Describe the health of your bear by comparing the amounts of food you collected to the required amounts.

3. Is the type of food a bear collects important? Why or why not?

4. Did you collect enough food and water to survive? If you did not survive, explain the difficulties in getting enough food and water.

5. What was the total number of food pounds collected by your class? If each bear requires 80 pounds of food to survive ten days, how many bears could this area actually support?

6. What factors in addition to food and water could influence the survival of bear populations?

Science as Inquiry

Roaming Deer

In this activity, you will explore how deer depend on their habitat. After completing this activity, answer the questions below:

1. Create a data table to record the number of deer for each round.

2. If each round represents one year, construct a simple line graph showing the number of deer as a function of time in years.

3. In this activity, what factors limit the number of deer in a given year?

4. Describe the pattern seen in the deer population over the entire time frame.

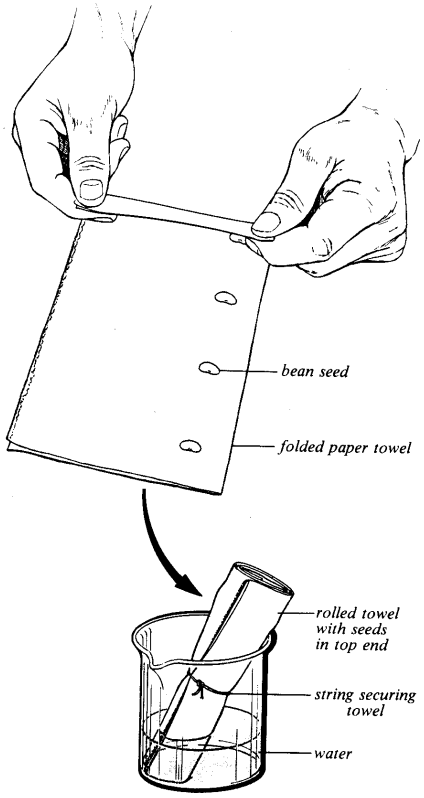
5. Describe several other limiting factors a deer population may experience.

6. What would happen to the deer population if limiting factors did not exist in this environment?

Science as Inquiry

How Does Your Garden Grow?

In this investigation, you will carry out a two-part experiment to determine the effects of water and temperature in seed germination. One part of the experiment tests the role of water, while the other part tests temperature as a factor.



Procedure:

On a stack of 3 or 4 paper towels, place 5 or 6 seeds in a straight line. Cover the seeds with another paper towel and roll the paper towels and seeds tightly. Proper rolling is important; see the diagram. Secure the roll with a rubber band. Follow this procedure to make 4 rolls of seeds.

Part

In this part of the activity, temperature is held constant. Water is considered a limiting factor. Obtain two beakers. Place one seed roll in each beaker. Make sure the seeds are at the top of the roll, sticking out of the beaker. In one of the beakers, put 100 mL of tap water. As time passes, add additonal water to keep the paper moist. Do not put water in the other beaker. Place both beakers in the same location at room temperature for 4–5 days. After waiting for several days, determine the number of germinated seeds in each roll. Get an individual group total as well as a class total. Determine the percent germination for each sample type, using both group and class totals.

Part B

In this part of the activity, water is held constant. Temperature is considered a limiting factor. Obtain two beakers. Place one seed roll in each beaker. Make sure the seeds are at the top of the roll, sticking out of the beaker. In both of the beakers, put 100 mL of tap water. Place one beaker at room temperature for 4-5 days. Place the other beaker in a refrigerator for the same period of time. After waiting for several days, determine the number of germinated seeds in each roll. Get an individual group total as well as a class total. Determine the percent germination for each sample type, using both group and class totals.

1. Create two tables to record seed germination results. One table should show your group results, the other should show class results.

2. Determine the percent germination in each seed roll.

3. Why did some of the seed rolls germinate better than others?

4. Describe the factors that may limit the number of seeds that germinate.

5. You've just planted a bunch of seeds outside in damp, warm, fertile ground. If it doesn't rain for the next 20 days, what will happen to your seeds?

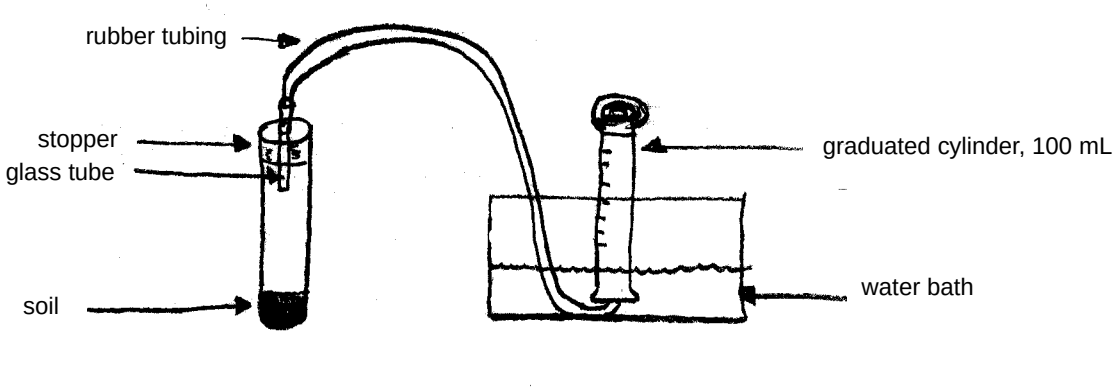
6. What would happen to your newly germinated seeds if they were planted and put in a dark room?

Science as Inquiry

What's Underfoot?

In this activity, you are going to investigate different soil types. You may collect your soil from gardens, vacant lots, forests or wooded areas, lawns or football fields, beaches or sandy lots, and stream banks. Look carefully at the numbers and types of living things you find in the spot where you collect your soil.

When testing your soil sample, include a control. Follow this procedure. Place a 1-gram soil sample in the bottom of a test tube. Fill a shallow pan with water. Fill the 100-mL graduate with water, invert it, and place it in the shallow pan. Place the rubber tubing inside the graduate. Do not let it slip out during the collection time. Refer to the diagram below. Add 10 mL of H_2O_2 to the soil. Stopper immediately. Why? What could happen if you didn't? Place the test tube in a test tube rack or beaker for support. Collect the gas for 10 minutes. Record the volume of gas collected by reading the graduate.



1. What types of living things did you see while collecting your soil?

2. How many different kinds of plants were there? Describe the number of large and small plants in the area.

3. What kinds of dead and decaying items did you see?

4. Create a table to record the different amounts of gas collected from class soil samples. Also, record the area from which each sample was taken.

5. Compare the area from which the soil was taken to the amount of gas collected. What conclusions can you make?

6. What limiting factors exist in the soil and plant communities you observed?

Science in Personal
and Social Perspectives

Brazil's "Green" Asphalt

The concrete and asphalt of the big Brazilian cities did not bury the wild animals, which still manage to find food and shelter in the urban jungle and grace it with their vivid beauty. In Rio de Janeiro small monkeys such as the *saguicomum* or common saki *(Callithrix jacchus)* "drop in" at apartments, and birds like the *quero-quero* or Brazilian lapwing *(Vanellus chilensis)* make their nests in the crowded Zona Sul. New species can even be discovered near the city centers of state capitals, as happened with a frog in Belo Horizonte.

Rio de Janeiro, with a population of 5.4 million, offers a particularly favorable setting with several biological reserves and a wide range of ecosystems including forests, sandbars and marshes. To be sure, the tapirs *(Tapirus terrestris)* described by the Frenchman Jean de Lery described in 1557 are gone, and the last jaguar was sighted in 1959. However, around 50 species of mammals remain, according to biologist Carlos Esberard of the Rio de Janeiro zoo. Opossums *(Didelphis marsupialis)* are common, and small felines, armadillos and the *tipiti* have survived. About 330 of the 480 bird species that used to exist in Rio are still present, according to ornithologist Fernando Pacheco of the Federal University of Rio de Janeiro.

Of the survivors, the sparrow-hawk *(Falco sparverius)* and large-billed hawk *(Buteo magnirostris)* show up in the very heart of the city. The beautiful green-headed tanager *(Tangara seledon),* found exclusively in the Atlantic forest, frequents the Botanical Garden. However, the scarlet macaw *(Ara chloroptera),* the blue-and-yellow macaw *(Ara araruna),* the red-and-blue macaw *(Ara maracana)* and the *guara* have disappeared. Rio de Janeiro still has some resident primates such as the *macaco-prego* capuchin monkey *(Cebus apella)* and the common saki, which has its origin in other states and took over the niche left by the *mico-leao-dourado (Leontopithecus rosalia),* a small monkey saved from extinction by an international campaign.

In Sao Paulo, with 9.6 million inhabitants, the only mammals for which there is room in the city proper are bats, skunks and a few rodents. Wild dogs *(Chrysocyon brachyurus),* however, still live in the 7,000 hectares of the Horto Florestal (tree nursery), though they are endangered. Maria Martha de Oliveira, an ornithologist at the University of Sao Paulo, notes that at least 120 bird species live in the city. This number may actually be larger, since it results from a preliminary census in 1966 which did not take in the entire city. Maria Martha points out that cities contain far more birds than most people think, because most people do not make a habit of observing animals. Many snakes also share the city with its human inhabi-

By Jorge Ferreira. Reprinted with permission from *Américas,* November/December 1993, p. 2. Américas is a bimonthly magazine published by the General Secretariat of the Organization of American States in English and Spanish.

tants. The records for 1988-92 show that 1,000 snakes were caught.

Belo Horizonte, the capital of the state of Minas Gerais, has a population of two million and ranks among the cities with the least green spaces. The preliminary study of the city's fauna started this year in Mangabeiras Park, which covers an area of 2.3 square kilometers at a distance nearly three kilometers from the city center. A new species of frog, *(Eleutherodactylus izecksohni),* was discovered in the park. Another unknown species is currently being examined.

A total of 197 species of birds were found in Belo Horizonte and, according to biologist Vencesli Firmino Silva, caimans and capybaras *(Hydrochaeris hydrochaeris)* have already been sighted un polluted Pampulha Lake. Between forty and fifty bird species can be found there, and one sighting not reported in the literature is claimed there: a starving caracara *(Milvago chimachima)* looking for mollusks.

Finally, from Alceo Magnanini, of the Environmental Engineering Foundation for the State of Rio de Janeiro, some words that should be taken to heart throughout the world: "If there were more trees in the parks and streets to feed the animals . . . we would have a much larger number of species."

* * *

Science as Inquiry

Starvation vs. Predation

Determining the factors that limit the growth of a population has always been a problem in ecology. Two limiting factors, food shortage and predators, have always been considered obvious, but there is increasing evidence that animals can control both factors.

However, there is a tradeoff. If the rate at which food is gained is increased, the risk of predation is also increased. In other words, an animal can decrease its probability of starvation by increasing its probability of being killed by a predator. Therefore, it is not meaningful to say that either food shortage or predators limit a population because the two interact and one must consider both factors simultaneously.

Reference
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By Erma Anderson, National Science Teachers Association, Arlington, Va.