



How Does the Environment Affect an Eagle Population?

5-1

LAB

▶ With unlimited resources and ideal environmental conditions, a population would continue to increase in size. This rarely happens, however, because resources are limited and environmental conditions are not ideal. The carrying capacity of an ecosystem is the maximum number of organisms that an area can support. In nature, many populations remain below the carrying capacity because of a combination of both nonliving (abiotic) and living (biotic) factors. These factors include climate, habitat, available food, water supply, pollution, disease, and interactions between species, including predation, parasitism, and competition. The interactions between a population and the many components of an ecosystem are very complex. In this Investigation, you will make a simplified model of the effects of some abiotic and biotic environmental factors on a bald eagle population.

OBJECTIVES

- Make a model to show how abiotic and biotic factors affect a bald eagle population.
- Hypothesize how biotic factors affect a bald eagle population.

MATERIALS



- | | | |
|---|-----------------------------------|----------------------------|
| index card | 20 cm × 20 cm pieces of paper (2) | scissors |
| uncooked rice grains dyed red with food coloring (75) | uncooked white rice grains (150) | graph paper |
| | metric ruler | colored pencils (6 colors) |

PROCEDURE

Part A.

Eagles mate for life. Only one pair of eagles occupies, defends, and hunts a well-defined territory.

1. Mark off the edges of the two sheets of paper in centimeters. On each sheet, draw a grid of 400 1-cm squares as shown in Figure 1. The grid represents a 4-km² lake (10 cm = 1 km) where the eagles hunt for fish. This will be their only source of food.
2. Cut two 1-cm squares from the index card. Label one of the squares M for male and the other F for female.
3. Lay the two grids near each other on a flat surface. Scatter 150 grains of white rice over one of the grids. Each grain represents a large fish in the lake. Eagles eat only the large fish.

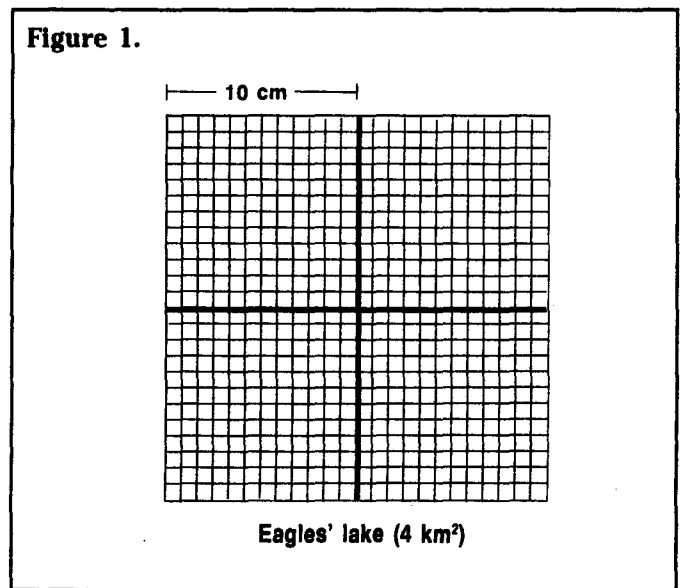
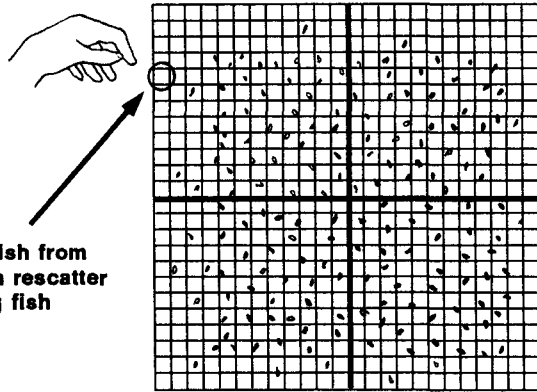
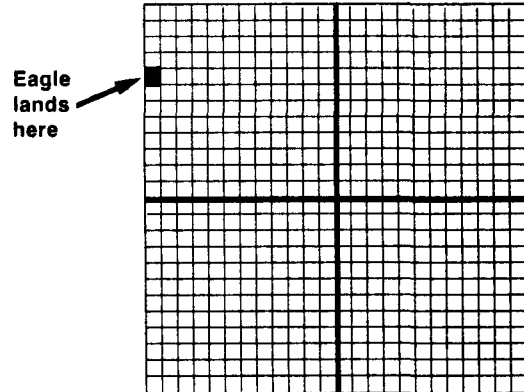


Figure 2.



Lake grid



Hunting grid

4. The other grid is the hunting grid. Hold the M (male eagle) square about 30 cm over the hunting grid and drop the M square onto the grid.
5. Note which grid square is most completely covered by the M square. Remove all of the rice from the corresponding square on the lake grid. Do the same thing with the F square. This process represents the eagles catching fish.
6. Each adult eagle hunts twice a day. Rescatter the remaining rice and repeat steps 4 and 5. Total the number of fish caught by each eagle on Day 1 and record the data for Day 1 in Table 1.
7. Repeat steps 4 to 6 nine times and complete Table 1. This observation is taking place in the fall when the fish population does not increase.
8. An eagle will share the fish it catches with its mate, but it will feed itself first. If an eagle does not eat a total of nine fish in any three-day period, it grows too weak to hunt and dies. Be sure to examine the data for each three-day period as you continue. If one eagle dies, continue hunting with only one eagle for the remaining days.
9. Graph the daily total number of fish from Table 1, using a colored pencil. Record the days on the horizontal axis and the number of fish on the vertical axis. Answer questions 1 and 2 in the Analysis section.
10. Make a **hypothesis** to describe what might happen if two ospreys (other birds of prey) also hunted in the lake, each averaging a take of three fish per day. Write your hypothesis in the space provided.
11. Return all the white rice to the lake grid. Repeat steps 4 to 8, but randomly remove an additional six fish per day that the ospreys catch. Record the data in Table 2.
12. Graph the daily total number of fish from Table 2, using a different colored pencil. Answer question 3 in the Analysis section.

Part B.

1. Rescatter all the rice as before.
2. Other factors in the ecosystem affect the fish population and, thus, the eagle population. Choose Factor D and any three other factors listed below. Follow directions for each factor. Record your data in Tables 3, 4, 5, and 6, labeling them properly. Be sure to rescatter the remaining rice before each hunting trip and scatter all the rice when you begin a new factor.
3. Graph the data from Table 3 through 6. Use a different colored pencil for each table.

Factors That Might Affect an Ecosystem

- A. A drought occurs that causes the water level of the lake to fall. This causes one quarter of the fish to die. Remove 38 fish from the lake. Repeat steps 4 to 6 from Part A ten times. Answer Analysis question 4.
- B. It is spring. The fish in the lake are spawning. Double the number of fish (rice grains). Repeat steps 4 to 6 from Part A ten times. Answer Analysis question 5.
- C. It is winter. The lake is frozen and the eagles cannot hunt fish. Answer Analysis question 6.
- D. Insecticides are sprayed on land near the eagles' territory. Some insects that have ingested the insecticide are eaten by small fish in the lake. The small fish are, in turn, eaten by large fish. When eagles eat fish contaminated with insecticide, they lay eggs that do not hatch. Remove half of the fish (75 of the white rice

grains) and replace them with fish contaminated with insecticide (75 red rice grains). Repeat steps 4 to 6 from Part A ten times. Answer Analysis questions 7 and 8.

- E. Phosphate pollution causes the algae in the lake to grow out of control. The algal growth reduces the amount of dissolved oxygen in the lake water and causes three quarters of the fish to die. Remove 112 fish. Repeat steps 4 to 6 from Part A. Answer Analysis question 9.

- F. The eagles have two offspring. The adults have to catch two additional fish a day. Repeat steps 4 to 6 of Part A. Answer Analysis question 10.

HYPOTHESIS

DATA AND OBSERVATIONS

Table 1.

Day	1	2	3	4	5	6	7	8	9	10
No. of fish										

Table 2.

Day	1	2	3	4	5	6	7	8	9	10
No. of fish										

Table 3.

Day	1	2	3	4	5	6	7	8	9	10
No. of fish										

Table 4.

Day	1	2	3	4	5	6	7	8	9	10
No. of fish										

Table 5.

Day	1	2	3	4	5	6	7	8	9	10
No. of fish										

Table 6.

Day	1	2	3	4	5	6	7	8	9	10
No. of fish										

ANALYSIS

1. How might eagle predation affect the fish population over time? _____

2. What effect, if any, might a small scale decrease in the fish population have on the eagle population?

3. Ospreys and eagles compete for food. What effect, if any, might the competition have on the eagle population? _____

4. Explain how a climate change might or might not indirectly affect the eagle population. _____

5. What effect, if any, does an increase in the fish population have on the eagle population? _____

6. How can a seasonal change affect the eagle population? _____

7. What effect, if any, does the insecticide have on the fish population? _____
on the eagle population? _____
8. Can a pollutant, such as an insecticide, affect one population in an ecosystem and not another? _____
9. Explain how pollution can indirectly affect the eagle population. _____

10. How does an increase in the eagle population affect the fish population? How is this situation similar to the competition from ospreys? _____

CHECKING YOUR HYPOTHESIS

Was your **hypothesis** supported by your data? Why or why not? _____

FURTHER INVESTIGATIONS

1. Perform an experiment to test the effect of competition among bean plants. Germinate about 25 bean seeds. Select and plant one seedling in a pot three quarters full of soil. This serves as a control. Plant about 18 seedlings in another pot of the same size and filled with the same amount of soil. Measure the growth of the seedlings.
2. Design and carry out an experiment to test the effect of overcrowding in a yeast population. Since yeast reproduces by budding, a population increases rapidly. Observe changes in the number of yeast cells in the population by making a wet-mount slide and counting the number of cells in the field of view. How do light and temperature affect a yeast population?