Real World Investigation 3-A

Skill Check

- ✓ Initiating and Planning
- Performing and Recording
- ✓ Analyzing and Interpreting
- ✓ Communicating

Materials

- graph paper
- coloured pencils
- access to the Internet

Zebra Mussels and Chlorophyll a in Lake Ontario

Year	Number of Zebra Mussels (per m^2)	Chlorophyll a (µg/L)
1990	0	4.4
1991	230	3.3
1992	500	3.4
1993	800	3.0
1994	1080	3.5
1995	1130	2.3
1996	770	3.6
1997	250	3.5
1998	410	3.3
1999	25	5.6
2000	25	2.8
2001	20	3.3
2002	10	3.6
2003	5	5.9
2004	no data	4.5

Math Skills

Go to **Math Skills Toolkit 3** for information about constructing a graph.

Zebra Mussels in Lake Ontario

Zebra mussels feed on phytoplankton, which are microscopic producers in aquatic ecosystems. The presence and productivity of phytoplankton are often inferred from the amount of chlorophyll a in the water. The table below contains data on the population of zebra mussels and the concentration of chlorophyll a in Lake Ontario from 1990 to 2004.

Question

How do zebra mussels affect the biotic and abiotic conditions in an aquatic ecosystem?

Prediction

Preview the data in the table, and make a prediction about the relationship between the two variables.

Organize the Data

Graph both sets of data on the same graph. Be sure to include a key to indicate what each data line represents.

Analyze and Interpret

1. Explain the relationship between changes in zebra mussel numbers and the concentration of chlorophyll a.
2. Infer how zebra mussels change the biotic conditions in an aquatic ecosystem. How could the changes affect the biodiversity of the ecosystem?
3. When the number of phytoplankton in water decreases, the clarity of the water increases. Light can penetrate deeper into the water as a result. How might this change to abiotic conditions in an aquatic ecosystem affect the biodiversity of the ecosystem?

Conclude and Communicate

4. Write an editorial article for a newspaper explaining why you think it is important for ships to sanitize ballast water before releasing it into the Great Lakes.

Extend Your Inquiry and Research Skills

5. **Research** In 2006, Transport Canada implemented the Ballast Water Control and Management Regulations. Find out more about these regulations. Explain how the regulations are an example of different countries and government agencies working together to protect an ecosystem.

Inquiry Investigation 3-B

Balancing Populations and the Environment

Skill Check

Initiating and Planning

✓ Performing and Recording

✓ Analyzing and Interpreting

✓ Communicating

Safety Precautions

- Use caution when working with the sharp pencil to make holes through poster paper.

Materials

- 2 sheets of white poster paper (32 cm × 32 cm each)
- ruler
- sharp pencil
- 32 square green sticky notes (4 cm × 4 cm each)
- bag of 100 checkers or similar objects (50 black and 50 red)
- calculator
- graph paper

A *commons* is a parcel of land that is shared by multiple users. In this type of arrangement, all individuals share the costs, but only some individuals experience gains. For example, cattle herders may share an area of common grazing land. If one herder puts more animals on the commons, that herder will gain. However, the other herders will experience poorer grazing land for their cattle without receiving any benefit. Therefore, they may be inclined to increase the size of their herds too, with the result that the commons becomes overgrazed.

Parks are modern examples of commons. One goal of a park manager is to maintain the resources of the park for the benefit of all its users over many years. An increase in demand for resources by any species affects all the other users of the park. In this investigation, you will play the role of park manager. Your job is to help maintain the deer population at or near the park's carrying capacity for deer. Recall that the carrying capacity is the maximum number of individuals of a species that an ecosystem can sustain.

Question

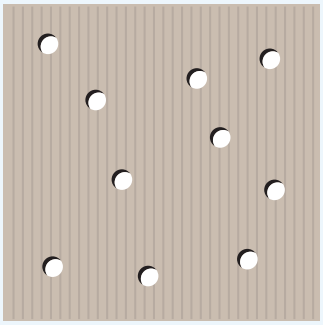
What factors might affect the equilibrium of a population, leading it to become out of balance with the carrying capacity of the ecosystem?

Hypothesis

Make a hypothesis about how the population of deer in a park will respond to pressures such as hunting, migration, seasonal changes, and mating.

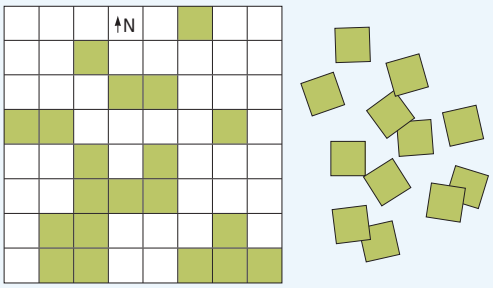
Procedure

1. Work in a group of four. On one sheet of poster paper, draw a grid of eight squares by eight squares. Each square should be 4 cm by 4 cm. This grid represents a provincial park. Indicate which direction is north, and give your park a name.
2. Prepare a hunting screen from the second sheet of poster paper. Using a sharp pencil, make 10 holes at random in the paper. Push the pencil through, rather than stabbing it through.



hunting screen

3. The 32 square green sticky notes represent land with sufficient vegetation for deer to graze. Stick all the squares onto your park, within the squares created by the grid lines. Think about how the pattern of squares you create might affect the deer. The 32 uncovered (white) squares represent land that is overgrazed or otherwise unsuitable for deer.

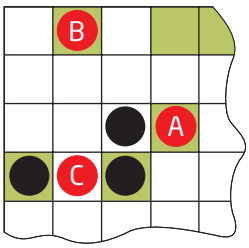


4. The black checkers are male deer (bucks), and the red checkers are female deer (does). To begin, stock your park with 32 deer randomly chosen from the bag. Place one deer on each green square. This population size (32) represents the carrying capacity of the park.

5. You will manage your deer population for five years. At the start of each year, you will establish a wildlife management policy. (For example, you may restrict hunting or supply extra food in the winter). During the rest of the year, the following four factors will affect the number of deer:
   - mating season (see Rules of the Game)
   - hunting season (see Rules of the Game)
   - immigration and emigration (see Rules of the Game)
   - seasonal impacts, either human or natural, such as a forest fire or flood, disease, deep snow, and poaching (These are not defined in the rules. It is for you to decide how much any of these impacts might affect the population each year, if at all. For example, a disease may sweep through the population, eliminating 10 percent of the deer. You would then randomly remove these individuals from your grid.)

Rules of the Game

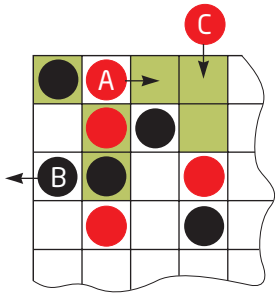
Mating Season Any doe that has sufficient nutrition (is on a green square) and has a buck in an adjacent square mates with him to produce one fawn. The fawn (choose a new checker randomly from the bag) is placed under the doe checker. At the end of each year, the fawns must move from their mother's care into a vacant adjacent square. If no suitable land (a green square) is available, the fawn must move to overgrazed land (a white square). If there is no vacant adjacent square in the park, the fawn dies and is removed from the board.



Rules for mating: Doe A can mate. Doe B cannot mate (no adjacent buck). Doe C cannot mate (on a white square).

Hunting Season Place the hunting screen on top of your park. Any deer that can be seen through the holes is shot by hunters and removed from the park–unless your management policy affects the hunting rules for the year. Each year, exchange hunting screens with a different group (or flip the screen to a different orientation).

Immigration and Emigration Any deer on a perimeter white square (overgrazed land) either moves to an empty adjacent green square or leaves the park (emigration). Any unoccupied good land (a green square) on the perimeter of the park is filled by new deer entering the park (immigration). Choose new deer at random from the bag.



Rules for migration: Doe A moves to adjacent green square. Buck B leaves park (no adjacent vacant green square). Doe C enters park (vacant green square on perimeter).

6. As a class, create a list of events for each of the five years, using all the factors in the order presented in step 5. All the groups will follow the same list, but different parks may get different results.

7. Make a data table, as shown below. After each event, record the number of deer in your data table. At the end of the game, make line graphs to display your data.

Deer Population over Time

Time	Factor	Number of Deer		
		Females	Males	Total
Start				
Year 1	Mating season			
	Hunting season			
	Migration			
	Seasonal impact			

8. Present your results to the class.

Analyze and Interpret

1. Was there a trend in the deer population in your park? Explain.

2. If you experienced a consistent increase or decrease in deer numbers, explain the main reason for this change. How could you achieve a more stable population?

3. Did different parks experience different results? If so, suggest the main cause of the differences.

4. How are the factors that determine the size of a deer population in a park similar to the factors that determine the human population of Canada? How are they different?

5. Over the past two centuries, the numbers and distribution of deer in parts of North America have varied greatly as a result of human activities. How would each of the following activities affect deer numbers?

   a. deforestation
   b. reforestation
   c. removing wolves
   d. restricting hunting

Conclude and Communicate

6. Local conservation groups want to re-introduce wolves into your park. As park manager, explain why you would agree or disagree with the proposal. List various effects that a population of wolves might produce in your park.

Extend Your Inquiry and Research Skills

7. **Inquiry** Suppose that you need to monitor the population of real deer in a park over a 10-year period. What methods would you use to measure the population? How often would you do a population count? What other data could you track that may affect population numbers?

8. **Research** In this investigation, you used a simulation to examine some of the factors that affect a deer population. Research how simulations are used in the study of ecology.