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

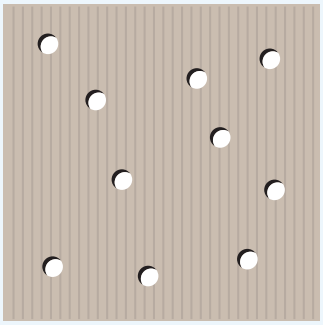
What factors might affect the equilibrium of a population, leading it to become out of balance with the carrying capacity of the ecosystem?

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.

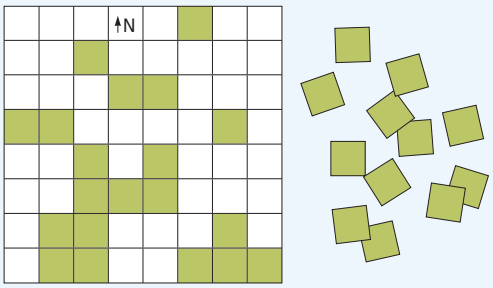
Procedure

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.



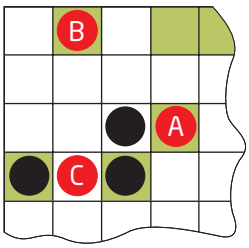
4. The black checkers are male deer (bucks), and the red checkers are female deer (does). To begin, stock your park with 32 deer randomly chosen from the bag. Place one deer on each green square. This population size (32) represents the carrying capacity of the park.

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

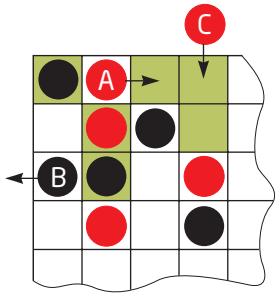
Mating Season Any doe that has sufficient nutrition (is on a green square) and has a buck in an adjacent square mates with him to produce one fawn. The fawn (choose a new checker randomly from the bag) is placed under the doe checker. At the end of each year, the fawns must move from their mother's care 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.

Chapter 3 Summary

3.1 Measuring Biodiversity

Key Concepts

- Biodiversity is the number and variety of organisms found within a specific region.
- Scientists have identified about 2 million species on Earth.
- Biodiversity is measured using several different methods.
- There are places on Earth where there is an exceptionally large number of species in a relatively small area.
- Most biodiversity hotspots are in tropical areas.

3.2 Communities

Key Concepts

- Species live in communities where relationships among different species are very important.
- Dominant species are very common primary producers.
- Keystone species are especially significant in maintaining an ecosystem through their relationships with other species.
- Ecosystem engineers alter a landscape in a way that makes it suitable for additional different species.
- Succession is the series of changes in an ecosystem that occurs over time, following a disturbance.

3.3 Threats to Biodiversity

Key Concepts

- Threats to biodiversity include habitat loss, the introduction of alien species, overexploitation, and breaking the connectivity among ecosystems.
- Deforestation and draining wetlands can result in habitat loss.
- Extinction is a natural event that has occurred throughout Earth's history.
- Current extinction rates may be accelerated due to human activities.

3.4 Restoration Ecology

Key Concepts

- Restoration ecology includes reforestation, wetlands restoration, controlling alien species, bioremediation, and bioaugmentation.
- The flow of nutrients through ecosystems can be interrupted by human activities, and restoration techniques can offset those interruptions.
- Alien species are extremely difficult to eradicate in most situations.
- There are many ecosystems that require restoration, and the Alberta tar sands will be a major challenge.

Chapter 3 Review

Make Your Own Summary

Summarize the key concepts of this chapter using a graphic organizer. The Chapter Summary on the previous page will help you identify the key concepts. Refer to Study Toolkit 4 on pages 566–567 to help you decide which graphic organizer to use.

Reviewing Key Terms

1. The current accelerated rate of extinction is known as _____. (1.3)

2. Human actions that protect and restore ecosystems for future inhabitants of the biosphere are examples of _____. (1.4)

3. The technique that purposely introduces an alien organism into an area to control an undesirable species is an example of _____. (1.4)

4. A series of ecosystem changes in a particular area over time is known as ecological _____. (1.2)

5. _____ is a technique used to remove soil toxins at sites that have been environmentally damaged by human activities. (1.4)

6. Taking individuals of threatened or endangered species into a breeding facility to increase their population sizes is known as _____. (1.2)

7. The number and variety of organisms found within a specific region is _____. (1.1)

Knowledge and Understanding K/U

8. Why is maintaining biodiversity on Earth important?

9. List and describe three methods that scientists use to measure biodiversity.

10. What is a biodiversity hotspot? Where are the most significant biodiversity hotspots found?

11. Explain how the birth rate and death rate of a species are relevant to the issue of extinction.

12. When was the most recent mass extinction, according to the fossil record? What organisms especially suffered at that time?

13. The dinosaur extinction has been linked to evidence that an asteroid hit Earth, causing climate change. What do scientists think caused the greatest mass extinction of all time?

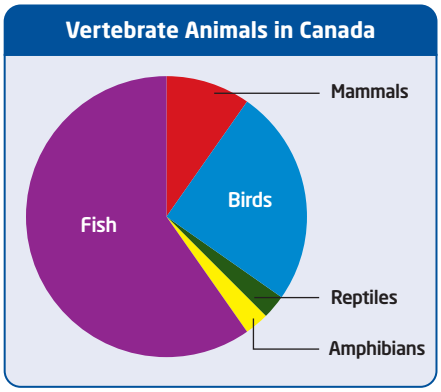
14. Is it possible to protect a species in trouble without regard to the community that it belongs to? Explain your answer.

15. Why is a place like Langara Island suitable for nesting sea birds, and why did their populations suffer losses?

16. Why is deforestation a threat to biodiversity?

Thinking and Investigation T/I

17. The circle graph below shows the proportion of animal species with backbones in Canada. Which group has the greatest biodiversity?



18. Elk eat aspen trees and other vegetation. Wolves eat elk (and other animals). Imagine a situation in which the wolves were eliminated long ago.

a. What impact might this have on the growth of new aspen trees that are needed to replace the old aspen trees?

b. What affect do you predict the re-introduction of wolves might have on aspen trees?

19. Imagine the same situation as in question 18. Prior to the re-introduction of the wolves, the number of beavers in this ecosystem dropped to zero. Beavers also eat aspen trees. Once the wolves were re-introduced, beavers started appearing in the area. Explain why the number of beavers increased after the wolves were re-introduced.

20. Should biocontrol methods that increase the numbers of predators or parasites in ecosystems be used against native species?

21. How could wildfires in forests have an effect on an ecosystem similar to the effects of organisms that are ecosystem engineers?

Communication C

22. BIG IDEAS Ecosystems are dynamic and have the ability to respond to change, within limits, while maintaining their ecological balance. Through the process of evolution, species change over long periods of time, and the communities and niches that they occupy must also change. Assume that no more alien species will be introduced into a particular ecosystem. Predict what might happen to the alien species already in this ecosystem over a long period of time.

23. BIG IDEAS People have the responsibility to regulate their impact on the sustainability of ecosystems in order to preserve the ecosystems for future generations. Choose an ecosystem or species that you like or value. What might you be willing to do as steward for this ecosystem or species?

24. The province is considering closing the Natural Heritage Information Centre, which maintains a database of the distribution and status of Ontario's biodiversity. As a concerned environmentalist, take a stand against this action. Identify three reasons why the centre should not be closed.

25. How would you make an argument for stewardship, based on ethics?

26. How would you make an argument for stewardship, based on practical issues?

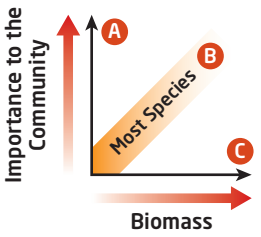
27. By making reference to the trophic pyramid from Chapter 1, explain why dominant species have to be primary producers.

28. The rivet analogy is used to explain why humans should be concerned about losing biodiversity. Provide another analogy to explain this concept.

Application A

29. Captive breeding programs are expensive. Are they worth it, in your opinion? Explain why or why not.

30. Where on the graph below would you argue that a keystone species fits: location A, B, or C? Explain your answer.



31. Biocontrol of purple loosestrife involves releasing several types of beetles that eat the leaves and new growth of the plants, destroy the roots, or interfere with seed production. Scientists believe that biocontrol can reduce the amount of purple loosestrife by 80 percent, but this takes 10 to 20 years. In cases where there is a high density of purple loosestrife covering a large area, biocontrol is the only option for removing the plants. Why do you think it is the only option?

32. Ships use ballast to adjust how they sit in the water. If you were involved in reducing the problems associated with unintentional introductions of alien species by ballast water, what would you propose?