

2.11 Explore an Issue

DECISION-MAKING SKILLS

- Define the Issue
- Identify Alternatives
- Research
- Analyze the Issue
- Defend a Decision
- Evaluate

Should We Use Pesticides to Control Pests?

For years, Ontario's tent caterpillar population will be fairly low; so low that the caterpillars can go virtually unnoticed. Then suddenly it seems that every other tree contains a caterpillar nest, and that the trees are being stripped of all their leaves (defoliated) (Figure 1).

The caterpillars are an example of a common phenomenon. Some species can reproduce so rapidly that they are capable of exceeding the carrying capacity of their ecosystem. Sudden spurts in one population can disturb even the most stable ecosystems. Such disturbances favour some species and hamper others (even to the point of completely eliminating them, at least temporarily). However, forces in the environment eventually cause the population to decline. A scarcity of food, an increased incidence of disease, or an increase in the predator population brings the population back into line.

The Caterpillar Problem

Tent caterpillars have one generation per year. They hatch in spring, about the same time as trees come into leaf, and begin to eat (Figure 2). The caterpillars reach maximum size by mid-July, at which point each one forms a pupa and begins its metamorphosis into the adult form. The adult moth emerges 10 days later and mates. Soon after mating the adults die, but not before the females lay their eggs. The life cycle continues the following spring.

Although their principal food is poplar leaves, tent caterpillars also eat the leaves of many other trees, including fruit trees. By eating a tree's leaves, the caterpillars prevent the tree from making and storing food. As a result the tree may be so badly weakened that it cannot reproduce (produce fruit). Most trees survive, but can make fewer leaves the following year.

If there is plenty of food for the caterpillars and if predators are few, many of the caterpillars become moths and reproduce. The result is a population explosion the following year. However, high populations of caterpillars mean plenty of food for predators, so the population of predators increases rapidly — their numbers will be high the following year. In addition, if there are many caterpillars,

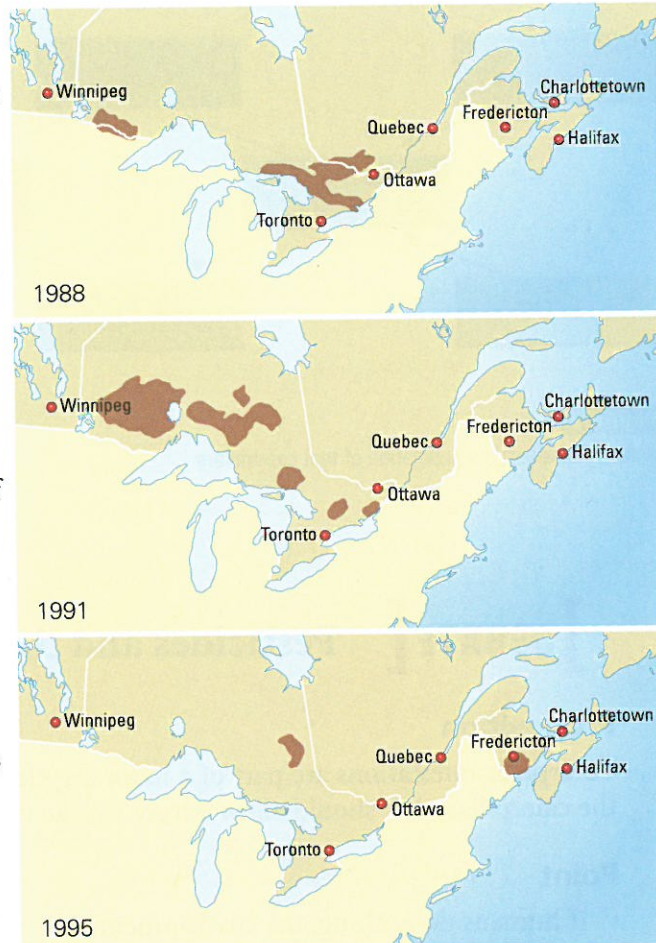


Figure 1

Brown areas indicate where tent caterpillars have completely defoliated trees. Trees that have lost their leaves in spring can grow new leaves later in the year, but the loss of time to gather food and the cost of growing new leaves weaken the tree.

Figure 2

Tent caterpillars spread out and eat the leaves of a tree during the day. In the evening, they all crawl into the web they make lower on the branch, where they are protected from predators.



damage to trees results in less food being available the following year. Both developments result in a dramatic drop in the caterpillar population in subsequent years (Figure 3).

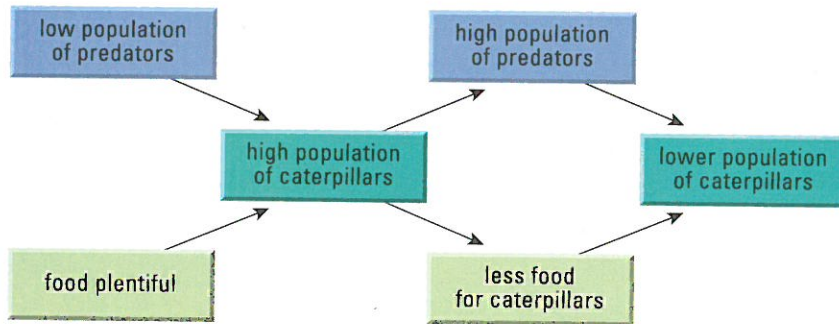


Figure 3

Factors that affect the population of tent caterpillars

Work the Web

To research tent caterpillars, visit www.science.nelson.com and follow the links from Science 10, 2.11.

Understanding the Issue

1. What factors control the population of tent caterpillars?
2. Make a list of individuals, communities, companies, and other organizations that would consider tent caterpillars a pest.

DEBATE

Pesticides and the Tent Caterpillar

Proposition

Caterpillar infestations are part of a natural cycle of events. Pesticides are not required to control the caterpillars. We should allow nature to take its course.

Point

- If humans do nothing, the environment adjusts. Infestations of caterpillars are followed by years when they are rare, and the forest regenerates.
- Insecticides may remove the pest and its predators. Often the predators, such as birds, are harmed more by the insecticide than the insect pest. If the result is a decline in the population of predators, an important control factor on the caterpillar population is removed.

Counterpoint

- Trees in urban areas don't adjust — there are no young trees to take the place of damaged trees. Infestations could damage thousands of trees in a town or city.
- Orchards and forestry companies can't afford to wait for predators to solve their problems. It could take 20 years or more to replace lost trees. Spraying and biological controls can keep populations in check before they get out of control.

Taking a Position

- ⓧ • In your group, discuss the proposition and the points and counterpoints above. Write down additional points and counterpoints suggested by your group.
- ⓕ • Decide whether your group agrees or disagrees with the proposition.
- ⓙ • Carry out research to learn more about the tent caterpillar, its economic effects, and the technologies used to control it.
- Ⓢ • Prepare to defend your group's position in a debate.

Chapter 2 Summary

Key Expectations

Throughout this chapter you will have had an opportunity to do the following:

- Describe the processes of photosynthesis and cellular respiration as they relate to the cycling of energy, carbon, and oxygen through abiotic and biotic components of an ecosystem. (2.1, 2.4, 2.5, 2.6)
- Illustrate the cycling of matter through biotic and abiotic components of an ecosystem by tracking nitrogen. (2.1, 2.6, 2.7, 2.8)
- Explain the process of bioamplification and assess its potential impact on the viability and diversity of consumers at all trophic levels. (2.2)
- Identify and evaluate Canadian initiatives in protecting Canada's ecosystems. (2.2)
- Describe careers that involve knowledge of ecology or environmental technologies, and use resources such as the Internet to determine the knowledge and skill requirements of such careers. (2.3)
- Assess the impact of technological change and natural change on an ecosystem. (2.7, 2.8)
- Examine the factors (natural and external) that affect the survival and equilibrium of populations in an ecosystem. (2.2, 2.9, 2.10, 2.11)
- Identify and research a local issue involving an ecosystem; propose a course of action; defend your position. (2.11)

Reflect on your Learning

Revisit your answers to the Reflect on your Learning questions, page 49, in the Getting Started.

- How has your thinking changed?
- What new questions do you have?

Key Terms

bioamplification	inorganic
biotic potential	law of the minimum
carbon cycle	law of tolerance
carrying capacity	mortality
cellular respiration	natality
closed population	nitrogen cycle
combustion	nitrogen fixation
denitrification	nutrient
density-dependent factor	open population
density-independent factor	organic
emigration	peat
fertilizer	pest
glucose	pesticide
immigration	photosynthesis

Make a Summary

In this chapter you learned how ecosystems change to remain vital. Matter cycles continuously through ecosystems through the birth, growth, and death of individual organisms.

- To summarize your learning select 15 of the Key Terms and write them on small file cards.
- Place the file cards on a desk and begin connecting the key terms with yarn or thread. Add key terms as required to make the connections.
- Be prepared to explain why you made each of the connections.
- View the maps made by other students in the class and ask them to explain why they made certain connections.

Chapter 2 Review

Understanding Concepts

- Label the following organisms as producers (P), consumers (C), or decomposers (D). Some organisms could belong to more than one category.
 - mushroom
 - pine tree
 - soil bacteria
 - bread mould
 - cougar
 - algae
- In your own words, define “matter cycle.”
- In your own words, define “bioamplification.”
- Using Joseph Priestley’s experiments, explain why plants are vital for the survival of animals.
- Copy **Table 1** and use it to compare photosynthesis with respiration. For items indicated with (?) put a check mark in the appropriate cell.

Table 1

Comparison	Photosynthesis	Respiration
raw materials		
products		
occurs in plants (?)		
occurs in animals (?)		
light is required (?)		
energy is released (?)		
energy is needed (?)		
chlorophyll needed (?)		

- Use the ecosystem shown in **Figure 1** to answer the following questions.



Figure 1

- Using the organisms in the ecosystem, explain the carbon cycle.
- In a flow chart explain how nitrogen in the air reaches the caterpillar.

- Figure 1** doesn't show any bacteria, but they are always present in ecosystems. What roles do bacteria have in the ecosystem?
 - If DDT were used to control mosquitoes in the ecosystem, which organism would end up with the highest concentration of the insecticide in its body? Explain your answer.
- In your own words, define “nutrient.”
 - Why do nutrients cycle faster in a tropical rainforest than on the tundra?
 - In your own words define:
 - nitrogen fixation
 - denitrification
 - Nitrogen is cycling through the ecosystems near your home and school. Choose a local natural wooded area and use a diagram to show how nitrogen cycles within this area.
 - Using the field mouse or the lemming as an example, explain the limits on the size of a population.
 - Calculate the change in a population of 1000 trumpeter swans after the following data were collected.

births = 300
deaths = 200
immigration = 4
emigration = 5
 - Is the human population of Ontario an open or a closed population? Explain.
 - Compare the populations in **Figure 2**:

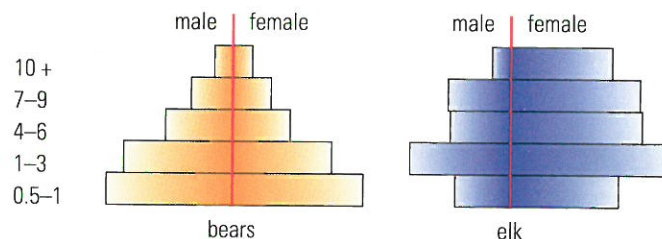


Figure 2

- Which population appears to be most stable?
 - Identify differences in the growth patterns of elk and bears.
 - Which population has undergone a recent hardship? Explain.
- What evidence have you gathered in this chapter that supports the statement that ecosystems must change to remain stable?

Applying Inquiry Skills

15. A lemming population was monitored in a study area (now in Nunavut) from 1986 to 1998. Use the data in **Table 2** to answer the following questions.

Table 2

Year	Population
1986	2200
1990	3050
1994	3200
1998	3500

- (a) Graph the changes in population.
 (b) Would you describe the growth pattern as exponential? Explain your answer.
16. A researcher conducts a study near Sudbury to find a possible biological control for pine bark beetles, an insect considered a pest by the forestry industry. The researcher sets up four different studies of predators and the pine bark beetle. The populations of prey and predator are monitored over many different generations. The graphs in **Figure 3** show changes in populations over time.
- (a) Which species is most likely the best controlling agent? Give your reasons.
 (b) Sometimes the eggs of a predator are eaten by its prey. Which predator might serve as a food source for its prey? Give your reasons.
 (c) Why is the population of predator A consistently lower than that of the pine bark beetle?
 (d) Predict what would happen to the population of pine bark beetles if predator species C exceeds the carrying capacity of the environment after year 9.

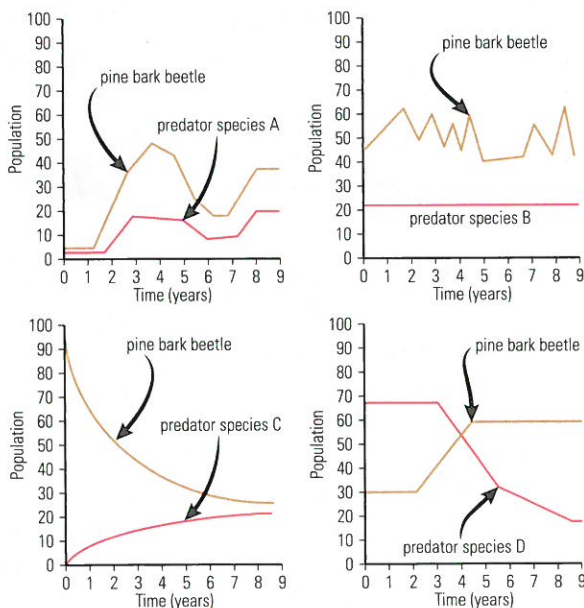


Figure 3

Making Connections

17. Using the example of pesticides and the spruce budworm, explain the impact of technological change and natural change on ecosystems.
- What might happen to a managed spruce and pine forest if pesticides are not used after an outbreak of budworm is noted?
 - Outline some potential difficulties that could arise if pesticides are the only strategy used to control spruce budworms.
18. When the population of white-tailed deer becomes large, they destroy the vegetation, drastically altering the entire ecosystem and placing other populations, both plants and animals, in peril. Once food supplies decline, the deer herd becomes more prone to disease and starvation. This problem is developing on Navy Island, near Niagara Falls. Controlled hunting has been proposed as a solution. There are several different opinions on whether hunting of white-tailed deer should be allowed on Navy Island.
- Identify the perspective for each of the statements below.
 - Do you agree with each statement? Give your reasons for agreeing or disagreeing.
 - Once deer populations increase beyond the food supply, the herd will become ill. Some will die, and others will be taken by predators, removing the weak from the population. This will eventually strengthen the herd — only the strong remain. Generally, hunters shoot only the largest and healthiest animals. Hunting will weaken the deer.
 - The beaches of Navy Island are visited regularly by the general public, and camping is allowed with a permit from the Niagara Parks Police. Hunting might create dangers for tourists.
 - There are no wolves or cougars on Navy Island, and introducing natural predators to control the deer isn't an option in tourist areas. Predators large enough to kill deer also pose threats to humans, pets, and farm animals. Hunting is the best control option.
 - If deer eat too much of the local vegetation, there will be no more food left and they will begin to starve. It is more humane to allow hunting than to allow the deer to starve.
19. Wolves often prey upon cattle or sheep as well as natural species, such as deer. Earlier in the century it was considered beneficial to eliminate predators. Identify and explain two harmful outcomes of this approach to managing predator populations.

Sustaining Terrestrial Ecosystems

Getting Started

WHAT IS THE VALUE OF AN ECOSYSTEM?

We drain wetlands to make way for more farmland to feed ourselves. We cut forests to supply wood and paper. We can place a value on farmland and timber, and we have systems to track that value. But what about the original ecosystem? What was its value, and what was the cost of changing it?

