

## Key Terms

stewardship  
restoration ecology  
reforestation  
biocontrol  
bioremediation  
bioaugmentation

**stewardship** the active assumption of responsibility for the welfare of the environment

## Sense of *time*

When thinking about environmental stewardship, Aboriginal peoples believe that the current generation should always work to protect the environment for the seven generations that will follow it.

## 3.4 Restoration Ecology

A *steward* is someone who is responsible for looking after someone else's property. Environmental **stewardship** is the idea that all humans are responsible for looking after a huge piece of property that belongs to all living things—the biosphere. There are both ethical and practical reasons for environmental stewardship. The ethical reasons are based on the idea of what is moral. For whom do we look after the biosphere? We look after the biosphere for other human beings, for future generations, and for other organisms, such as the spotted turtle in **Figure 3.20**. The practical reasons can be summarized using an analogy made by an ecologist.

### An Ecosystem Analogy

Suppose that you are in a jet taking off, and you see that one out of hundreds of rivets holding the wings together is missing. You are not too worried. After all, engineers “over-engineer” such structures so that they are much stronger than the stresses placed on them. However, if you see that dozens of rivets are missing, you might begin to worry. The jet might not be “sustaining” or “enduring,” meaning that a crash is likely.

Just as rivets hold an airplane wing together, species hold ecosystems together. There are some special “rivets” that ecosystems cannot afford to lose, such as the keystone species you read about in Section 3.2. However, ecosystems tend to be over-engineered with lots of rivets too, especially rivets with high biodiversity. Most ecosystems might remain sustainable with the loss of one or two rivets, but as more rivets are lost, the ecosystems will lose their ability to sustain the remaining species, including humans.

**Figure 3.20** The radio transmitter on this spotted turtle, a rare species in Ontario, helps biologists learn more about its life history.



## Restoring Altered Ecosystems

For most of modern history, human actions have proceeded without much thought to the sustainability of the ecosystems. As scientists learn more about the effects of human actions on ecosystems, however, more attention is given to decreasing human impact on ecosystems and restoring those that have already been altered. A major goal of restoration ecology is to stimulate natural processes of regeneration to produce a sustainable, if not identical, ecosystem. **Restoration ecology** is the renewal of degraded or destroyed ecosystems through active human intervention.

### A Restoration Plan

The Don Valley Brick Works, shown in **Figure 3.21**, was a business that operated for almost a century, at what was once the edge of Toronto. Bricks were made at the site, and rock was mined in a quarry there.

The site was purchased as conservation land in 1990, and the restoration plan was implemented in 1994. The old quarry was filled in, using material excavated from a site in downtown Toronto. In addition, the site was landscaped to create a series of three ponds, using water diverted from Mud Creek, a stream that passes through the site. The first pond captures sediment carried by the current, and plants in the other two ponds filter the water before it flows into Lake Ontario. The ponds are a feature of interest for visitors. They also provide habitat for wildlife, including migrating birds that seek green spaces when they make stops in urban areas. Mud Creek itself, which had been buried underground for decades, was uncovered using a restoration technique known as *daylighting*.

**restoration ecology** the renewal of degraded or destroyed ecosystems through active human intervention

### Suggested Investigation

Inquiry Investigation 3-B, Balancing Populations and the Environment, on pages 118-120

**Figure 3.21** Ecological restoration has converted Toronto's Don Valley Brick Works (shown in 1891 and today) into a natural environment and cultural heritage park that includes wetlands, a boardwalk, a wildflower meadow, and restored historic buildings.



### Learning Check

1. What is stewardship?
2. What does *daylighting* mean to a restoration ecologist?
3. How can a series of ponds be used to improve water quality?
4. Connect the terms *stewardship* and *restoration ecology*.



**reforestation** the regrowth of a forest, either through natural processes or through the planting of seeds or trees in an area where a forest was cut down

### Study Toolkit

**Word Origins** How do you think the words *restoration* and *reforestation* are related?

## Restoration Methods

Restoration ecologists use many techniques to restore sustainable ecosystems.

### Reforestation

**Reforestation** is the regrowth of a forest, either through natural processes or through the planting of seeds or trees in an area where a forest was cut down. The regrowth of a forest takes many years, but, with proper planning and management, it can be done successfully. In the early 1900s in eastern Canada, red pine trees were planted in some areas that had previously been cleared for agriculture by European settlers. As the rows of red pines matured, the trees provided shade under which the seeds of native trees grew. Natural succession, shown in **Figure 3.22**, in these areas over the past 80 years has yielded the gradual return of native tree species such as the sugar maple, American beech, hickory, and ash.

**Figure 3.22** Red pines, which were planted to control soil erosion, helped to accelerate natural forest succession.

**A** Forest was cut down to use the land for agriculture. **B** Red pine trees were planted to reforest the area. **C** As the red pines grew, they provided shade under which other species grew. **D** After many years, natural succession occurred, and there was a gradual return of native species.



**Figure 3.23** Water control structures are used by wetland conservationists to help restore and maintain water levels.

### Wetlands Restoration

The story of Alfred Bog, which you read about at the beginning of this chapter, is just one example of how existing wetlands are being protected today. But what happens to wetland areas that were drained and the land used for other purposes? Many government agencies and non-profit organizations across Canada are working to restore some of these areas. Wetland restoration is a process in which a wetland is, to the greatest extent possible, returned to its natural state in terms of soil quality and composition, water coverage, the type of plants that grow there, and the habitat. In southern Ontario, the Ministry of Natural Resources in Norfolk County has begun a Wetlands Drainage Restoration Project. Through this project, potential restoration sites are identified and water is allowed to return to natural levels through the use of water control structures, like the one shown in **Figure 3.23**. Since 1996, efforts related to the project have restored numerous wetlands in Norfolk County.

## Controlling Alien Species

Recall, from Section 3.2, that an alien species can upset the equilibrium of an ecosystem. Being able to successfully control the spread of an alien species is an important part of maintaining sustainable ecosystems. Biocontrol and chemicals are two methods that ecologists use to help control alien species.

**Biocontrol** The European gypsy moth, shown in **Figure 3.24**, escaped from an American lab into the forest ecosystems of eastern North America in the 1800s. The species then began to spread, and it remains a serious forest pest in many areas, including much of Ontario. These moths feed on tree leaves, and, during peak years, they can remove all the leaves on a tree. To battle this pest, a European fly called a parasitoid was introduced, as a form of biocontrol. **Biocontrol** is the use of one species to control the population growth or spread of an undesirable species. The parasitoid was known to lay its eggs inside the gypsy moth caterpillar, eventually killing it.

Although the parasitoid fly probably helps to regulate the European gypsy moth here, it has two traits that make it a problem for the ecosystem. First, it has several generations each summer, whereas the gypsy moth has only one. Second, the fly has to overwinter inside a caterpillar, but gypsy moths overwinter as eggs. Consequently, the fly also must attack native moths. One study showed that 81 percent of robin moths, the largest moth found in Ontario, were attacked by the alien fly.

**biocontrol** the use of a species to control the population growth or spread of an undesirable species



**Figure 3.24** Gypsy moths can eat all the leaves on a tree.

## Activity 3-5

### The Common Good

Most resources are shared by many organisms. What problems occur when a population shares a limited resource?

#### Materials

- bingo chips or similar items (100 per group)
- watch or clock

#### Procedure

1. Arrange your team of about 10 in a circle.
2. Place 100 chips in the centre of each team's circle.
3. Each team will "harvest" chips from its supply for short periods of time (between 30 s and 2 min). Your teacher will signal the start and end of each harvest. Your goal is to obtain the maximum points for your team.
4. Points are obtained as follows:
  - Each student obtains one point for every 10 chips she or he harvests.
  - At the end of each harvest, the supply of chips that remains in the centre of each group will be doubled (up to a maximum of 100 chips).

- The group with the largest supply of chips left in the centre after each harvest will obtain one point for each student in the group.
5. Carry out the first harvest and calculate the total points obtained by each group.
  6. Repeat the harvest three more times.

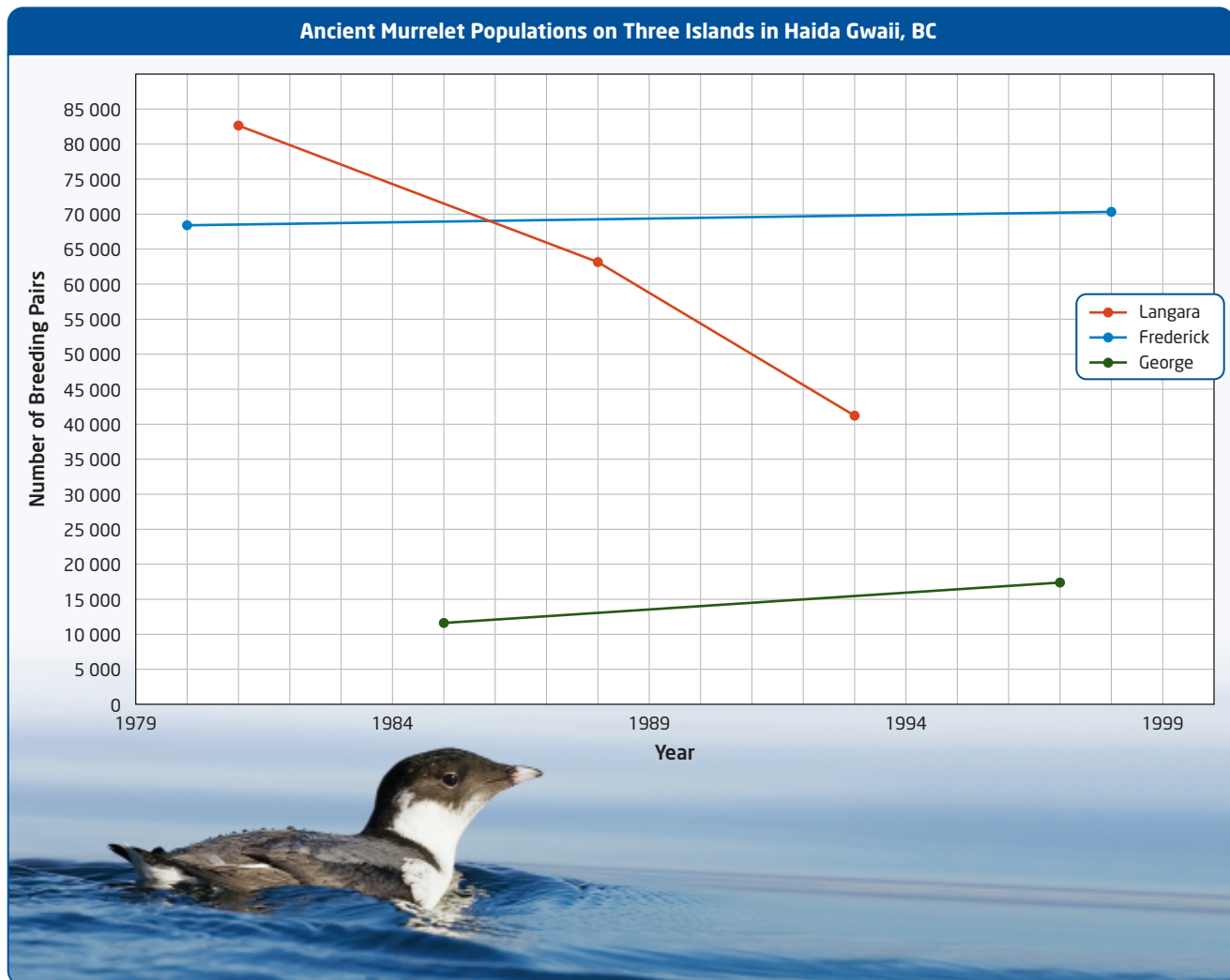
#### Questions

1. What strategies of harvesting led to the greatest decline in a team's resources (the chips)?
2. What strategy of harvesting led to the highest number of points obtained by a team?
3. Is the strategy that provides maximum points to individuals the same as the strategy that provides maximum points to groups? Explain.
4. Suggest some real-life resources that the chips in the model might represent.

## Sense of place

Langara Island, as well as Frederick Island and George Island, is part of a group of islands called Haida Gwaii, off the coast of British Columbia. Haida Gwaii means “islands of the people.” Haida Gwaii is also referred to as The Queen Charlotte Islands.

**Chemicals** Sometimes, chemicals can be used carefully with success. Langara Island, off the coast of northern British Columbia, is home to countless nesting sea birds, including burrowing species. The island suits such birds because it was, originally, relatively predator-free. Then two alien species of rats, Norway rats and black rats, were accidentally introduced by ship. The rats ate birds’ eggs and nestlings, causing the island’s bird population to decline steadily. For example, the population of ancient murrelets, shown in **Figure 3.25**, was reduced by almost 40 000 individuals after the rats arrived on the island. Trapping failed to eliminate the rat population, but a poisoning campaign succeeded. Bait containing the poison was placed around the island for the rats. Although other animals, such as ravens and shrews, were also affected by the poison, the rats suffered a devastating population decline as a result of the poisoning campaign. By 1996, the rats had been eliminated from Langara Island. Since then, the population of ancient murrelets has rebounded.



**Figure 3.25** Following the accidental introduction of foreign rats around 1981, the colony of ancient murrelets on British Columbia’s Langara Island dropped steadily. No rats were introduced to nearby Frederick Island or George Island.



## Bioremediation and Bioaugmentation

*Bio* means life. In **bioremediation**, scientists introduce living plants and fungi to do more than simply revegetate landscapes. Certain plants are grown at toxic sites because they clean soils by collecting the poisons in their tissues. When these plants are harvested, the soil quality is improved. In another example, bacteria have been used with some success to break down oil from oil spills that damage coastline ecosystems.

Bioaugmentation is another restoration tool. **Bioaugmentation** is the use of organisms to add essential nutrients to depleted soil. For example, the clover shown in **Figure 3.26** is often planted to replenish nitrogen levels in soil. Recall that nitrogen is an important nutrient for plants.



**Figure 3.26** Clover is often planted to replenish nitrogen levels in soil.

## The Future of Restoration Ecology

Given population growth and the related widespread alteration of ecosystems, this century will require humans to restore and enhance sustainable ecosystems. Restoration ecology has developed tremendously, but many challenges remain, including the sometimes slow pace of recovery, the restoration of a different type of ecosystem than planned, the requirement of continuous intervention, and projects of very large scale, such as the Alberta Tar Sands, shown in **Figure 3.27**. The extraction of petroleum from the Alberta Tar Sands involves almost total destruction of huge areas of boreal forest, as well as the production of tremendous volumes of *tailings* containing toxic waste. The scale of this project promises to be a major challenge for restoration.

**bioremediation** the use of living organisms to clean up contaminated areas naturally  
**bioaugmentation** the use of organisms to add essential nutrients to depleted soils



**Figure 3.27** Removal of petroleum from the Alberta Tar Sands leaves the area almost completely devastated.

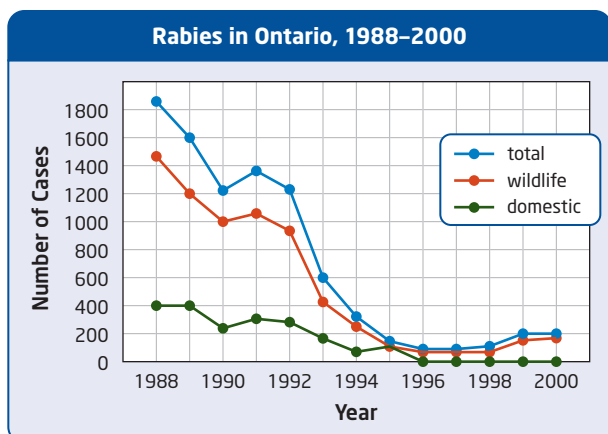
## Section 3.4 Review

### Section Summary

- 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.

### Review Questions

- A** 1. Make a list of actions you take that contribute to environmental stewardship.
- K/U** 2. What kinds of human activities create the need for restoration ecology?
- K/U** 3. Use **Figure 3.21** to help you explain how the restoration of the Don Valley Brick Works is an important example of the support of ecological restoration in cities.
- C** 4. Recall, from Chapter 1, that modern societies use fossil fuels at high rates. Extraction of petroleum from the Alberta tar sands requires deforestation and removal of soils, both of which have very significant effects on the environment. Write a short paragraph stating your opinion on this issue. Should petroleum be extracted in this way? Why or why not?
- K/U** 5. List some methods that can be used to eliminate alien species.
- A** 6. Langara Island is approximately 6 km by 5 km. How successful do you think a poisoning campaign to eliminate non-native rats would be on New Zealand's two main islands, each of which has an area of over 100 000 square km? Explain your answer.
- T/I** 7. The Ontario government began dropping tens of thousands of food baits inoculated with a vaccine against rabies, an alien virus, in 1989. The graph on the right shows the number of cases of rabies in Ontario from 1988 to 2000. Based on the data in the graph, do you think the campaign to control the spread of the rabies virus has been successful? Explain your answer.
- K/U** 8. How have bacteria been used in restoration ecology?



The Ontario government launched a campaign against the spread of rabies.