Human Impact on Ecosystems

TOPIC 7

What do You Think?

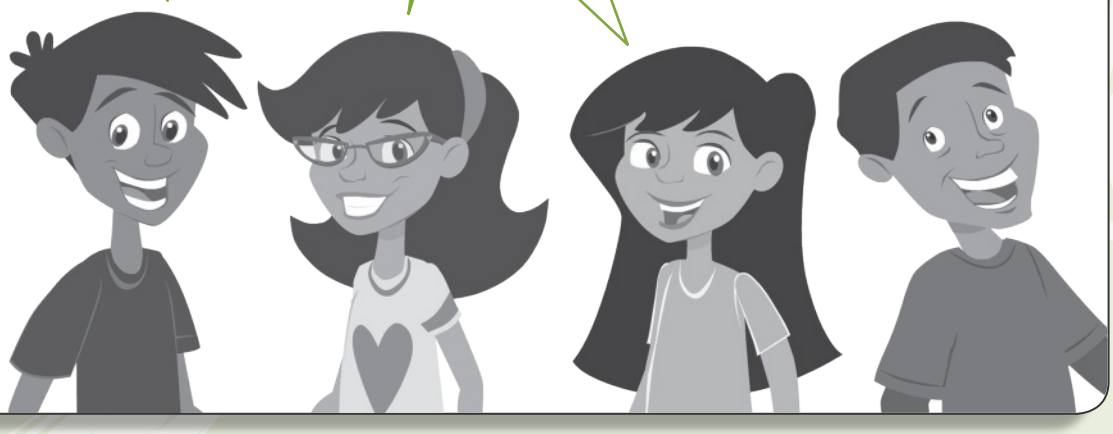
Global Warming

The hole in the ozone layer is the cause of global warming since it lets in more heat from the sun and warms the polar regions of the Earth.

Global warming is really a natural process. The Earth was first very cold and it has been getting warmer ever since.

Plants are a major cause of global warming since they give off so much carbon dioxide.

Global warming is partly the result of our burning so much fossil fuel like coal and gasoline.



TOPIC 7

Human Impact on Ecosystems

Vocabulary

carrying capacity	global warming	pollution
deforestation	industrialization	renewable resource
direct harvesting	nonrenewable resource	technology
energy flow	nuclear fuel	trade-off
fossil fuel	ozone shield	water cycle

Topic Overview

All living things affect the environment around them. Porcupines chew the bark from trees; squirrels break twigs as they leap from branch to branch. Generally, the changes to the environment are small. Humans, however, have made impressive technological achievements in the past few hundred years. As a result, we are now making significant changes in Earth's diverse environments. As the human population grows and our need for the resources to sustain our technology expands, the possibility that we will harm Earth's ecosystems increases. Our decisions about how to use—or misuse—Earth's resources will have a profound impact on all the organisms that depend on those resources.

Need for Awareness and Understanding

Human activities can create ecological problems that must be avoided or corrected. If we are to find solutions to those problems, we must encourage everyone to become environmentally literate. That means people need to understand the causes and effects of environmental problems as well as the possible solutions that could lead to environmental stability. Because environmental issues often concern many countries, resolving environmental issues frequently requires global awareness, cooperation, and action.

Our Environment

Like all living things, humans are part of Earth's natural ecosystems. We depend on our ecosystem to supply the food we eat, the water we drink, and the air we breathe. As long as our ecosystem functions normally, those essential resources will be available. We can continue to depend on the plants in the ecosystem to provide food and oxygen and to recycle the carbon dioxide we exhale. We will also be able to rely upon our ecosystem to maintain the quality of our water.

Limited Resources

Earth has a finite supply of resources. Some of Earth's resources, such as our food supply and solar energy, are renewable. Given sufficient time,

renewable resources can be replaced. Other resources, such as fossil fuels and minerals, are **nonrenewable resources.** Once they're used, they cannot be replaced. Decisions we make today and tomorrow will determine whether or not we increase our consumption of Earth's limited resources. One way to reduce our use of resources is to control the growth rate of our population. An ever-increasing human population accelerates the use of Earth's limited resources. Making the right decisions about these issues will affect you as well as the future generations of all the organisms that share the biosphere.

Figure 7-1. A commercial fishing trawler

Renewable Resources Although many resources are renewable, they must be used carefully. Increased consumption can stress the natural processes that renew some resources. As a result, the resource might be unable to renew itself. For example, the fish we eat are a renewable resource. Even if many fish are captured, over time the fish populations can reproduce and recover their losses. Today, however, modern, commercial fishing (see Figure 7-1) can remove so many fish so quickly that specific populations may not have time to recover. In some cases, the reduction can be so severe that the fish population may fail to reproduce. At that point, the fish would no longer be a renewable resource.

Nonrenewable Resources Our increasing consumption of resources that cannot be replaced naturally is becoming a serious problem. Most metals, such as the aluminum we use for packaging, and other minerals, such as the silicon we use for computer chips, are nonrenewable resources. Fossil fuels, such as the gas that runs our cars and the coal that powers many factories, are also nonrenewable resources. Using too many nonrenewable resources will cause their depletion (serious reduction) within a relatively short time.

Preserving Our Resources Individuals can help maintain our supply of both renewable and nonrenewable resources by practicing the three R's: Reduce, Reuse, and Recycle. Suggestions are included in Table 7-1.

Natural Processes in Ecosystems

Several natural processes that occur in ecosystems affect the life and health of humans as well as all the other organisms that rely on the ecosystem. Some activities of humans affect these processes, and most of the changes are likely to be detrimental, or damaging, to the ecosystems. For example,

Table 7-1. How Individuals Can Preserve Resources

The 3 R's	Action	Example
Reduce	Avoid using the resource.	Use energy efficiently; walk, bike or carpool instead of driving.
Reuse	Use the same product over and over, instead of throwing it away after one use.	Use dishes rather than paper plates. Instead of discarding your paper lunchbag, take it home and use it again.
Recycle	Don't throw it in the trash. Instead, discard the product in a way that it can be used again, or to make another product.	Paper, metal, plastic, and glass are all easily recycled. Donate unwanted clothing, books, and furniture to charitable organizations.

if **pollution**—a harmful change in the chemical makeup of the soil, water, or air—spreads to a particular habitat, some of the species that live in that habitat will suffer. The stability of the ecosystem and the variety of species that live in it might be threatened.

Maintaining Atmospheric Quality Throughout the biosphere, animals take in oxygen during respiration and release carbon dioxide. Plants and algae take in carbon dioxide during photosynthesis and release oxygen. Through the biotic processes of respiration and photosynthesis, the levels of carbon dioxide and oxygen in the atmosphere are kept in the range that is suitable for life.

Abiotic factors also help maintain the quality of the atmosphere. For example, as it falls, rain cleans the air of particles and soluble gases. The rainfall also helps maintain humidity in the atmosphere.

Soil Formation Soils form when weathering breaks down rocks and when organic materials from decaying plants and animals accumulate. Such soils support the growth of many producer organisms and serve as a habitat for decomposers. The root systems of plants hold the soil in place. If the vegetation that covers the ground is removed, the soil can be washed away by rain or blown away by wind. Soil erosion sometimes occurs during a drought when many plants die, leaving bare soil.

The Water Cycle Water continuously evaporates from the surface of the land and water and from the leaves of plants. The water vapor rises into the atmosphere and collects as clouds that can move long distances. Eventually, the vapor condenses as precipitation, which is distributed over many areas of Earth. The water collects as runoff or groundwater or evaporates. The process by which water continually moves from Earth's surface to the atmosphere and back is called the **water cycle,** and is shown in Figure 7-2. Many ecosystems maintain a supply of fresh water, which is available to all organisms, including humans.

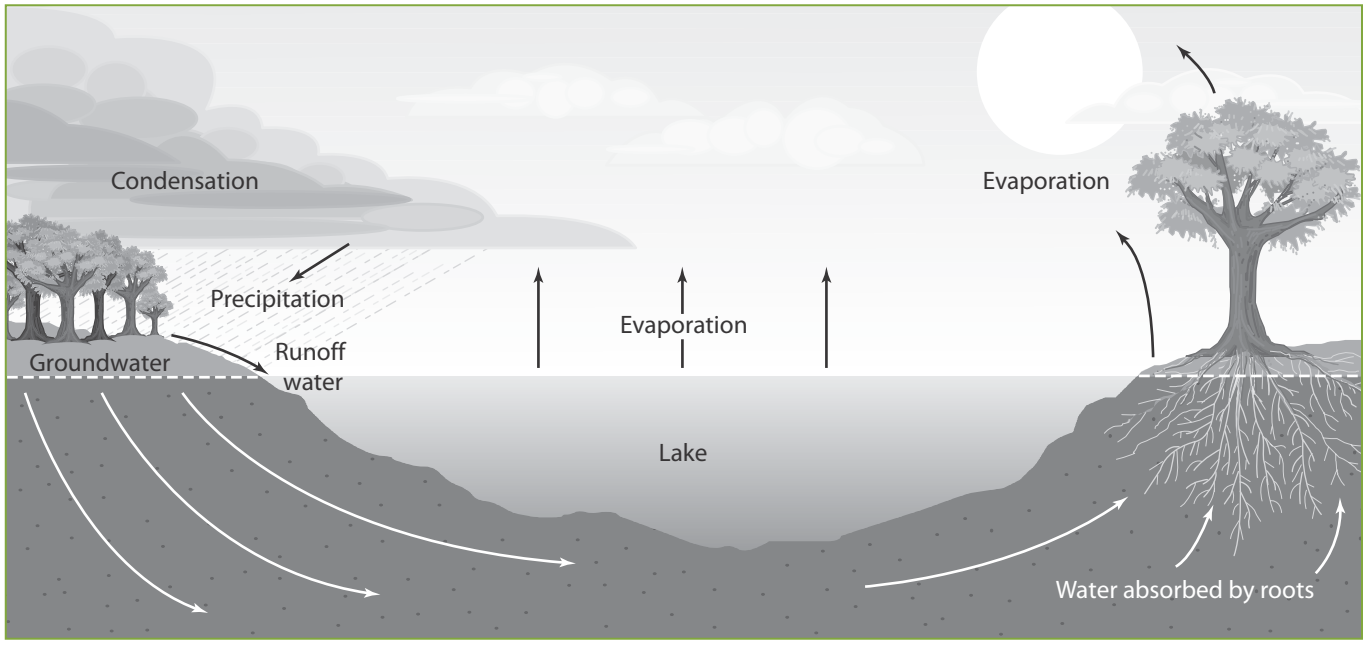


Figure 7-2. **The water cycle**

Waste Removal and the Recycling of Nutrients Plants that live in the soil use the soil's minerals as they grow. Nutrients are transported from one organism to another through the food chains in the ecosystem. Those that are not released into the atmosphere are eventually contained in the dead bodies and wastes of organisms. Decomposers break down the wastes and the dead bodies of organisms, removing the nutrients in the process. The nutrients are then restored to the soil, where they can then be used by other plants, continuing the cycle.

Without this natural recycling, much of the abiotic materials needed by living organisms would remain "locked up" in the bodies of dead organisms. Minerals and other nutrients would not be available for new organisms. In tropical forests, where heavy rains are frequent, decomposition and the recycling process must take place rapidly. Otherwise, the frequent rains strip the land of minerals before new plants can absorb and use them. In areas where the Amazon rain forest has been cleared and burned for planting, many nutrients have been washed away, leaving the soil unfertile.

Humans sometimes make use of this natural recycling process when they mix decaying lawn and garden wastes to make compost, which is a natural fertilizer and soil conditioner. Adding compost to the soil recycles wastes naturally and reduces the need for chemical fertilizers. It also reduces the amount of waste material in landfills and eliminates the need to burn yard waste, which pollutes our atmosphere.

The Flow of Energy Food chains, food webs, and energy pyramids illustrate the **energy flow** through ecosystems. Each organism has a role in the process and contributes to the overall stability of the ecosystem. As a result, losing all or most of the members of any species of an ecosystem could upset the stability of the whole ecosystem.

Energy is passed through the environment, but unlike nutrients, it does NOT recycle. Instead, at each feeding level in an energy pyramid, organisms lose large amounts of energy (as heat) to the environment. This energy cannot be recaptured by living things. Because of this constant energy loss, ecosystems need a constant source of new energy. That energy source is usually the sun.

People and the Environment

Because humans are part of Earth's ecosystems, they affect the way ecosystems function. They also are affected by changes in the ecosystem. Once the ecosystem is damaged, people may suffer from that damage just like any other species.

Population Growth

Most species in new environments can have a period of rapid population growth. The population increase levels off as it approaches the ecosystem's **carrying capacity,** which is the number of individuals of a species the environment can support. For example, as rabbits move into a field, their population may boom. Eventually, the food supply dwindles, and the scarcity of food leads to a reduction in the population of rabbits. Those that do not get enough to eat may become too weak to escape predators or

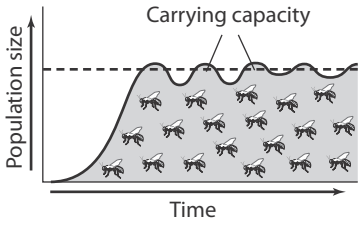


Figure 7-3. A population growth curve: In a new environment, the population usually increases quickly, but it stabilizes when it reaches the carrying capacity of that environment.

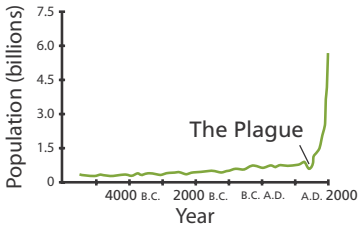


Figure 7-4. Growth curve for the human population worldwide

recover from diseases. Some may even die of starvation. The population growth levels off when the number of rabbits is balanced by the availability of food and the presence of limiting factors, such as predators. The relationship between population and the carrying capacity of an environment is shown in Figure 7-3.

Earth can only support a certain number of people. Our planet has a carrying capacity for humans just as it does for other species. The more people there are, the more resources they need. These resources come from the environment. More people also produce more waste, which must be disposed of or recycled. Overcrowding and lack of food also become problems when populations are very large.

For thousands of years, the human population grew slowly. Then about 300 years ago, our food supply began to increase, and improvements in health care and hygiene led to dramatic increases in our population. At present, the population curve inclines steeply upward. To many population scientists, the sharp increase suggests that the human population is growing at a dangerously fast rate. Compare Figure 7-4, the growth curve for the human population, with Figure 7-3, the growth curve typical for animals in an ecosystem.

If the human population continues to grow at the rate shown in Figure 7-4, Earth's carrying capacity could be reached soon. That result could be catastrophic. With no controls, the human population might even overshoot Earth's carrying capacity for our species. There might not be enough food, water, space, and/or oxygen. The resulting deaths from famine, disease, or wars over resources could reduce the human population to a small fraction of its present level. Finding ways to slow our population growth so that the growth rate levels off before Earth's carrying capacity is reached could save future generations from suffering the consequences of unlimited population growth.

Review Questions — Set 7.1

1. Which of these resources is renewable?
(1) wood
(2) oil
(3) iron
(4) coal

2. The best way to ensure that there will be enough aluminum for all future needs is to
(1) dig more mines and process more aluminum ore
(2) buy more aluminum from other countries and save our own
(3) recycle and reuse aluminum
(4) increase space exploration and search for new sources of aluminum

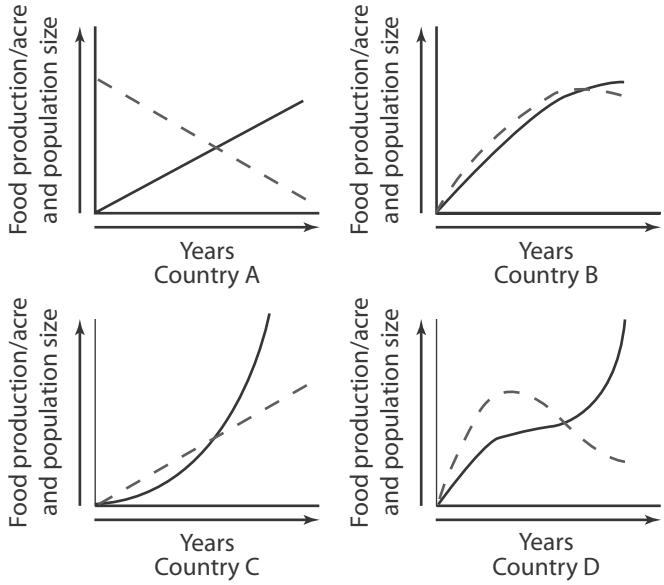
3. Some ecologists are concerned that the human population has outgrown the capacity of many of Earth's ecosystems. The natural limiting factor that will most likely prevent further human population growth in many parts of the world is
(1) habitat destruction
(2) political intervention
(3) food supply
(4) social intervention

4. Which of these human activities is quite often responsible for the other three human activities?
(1) increasing demand on limited food production
(2) rapid increase of loss of farmland due to soil erosion
(3) rapid increase of human population
(4) increasing levels of air pollution

5. The graphs on the right show the size of the human population in relation to food production per acre in four different countries over the same period of time.

Which country's population appears to have reached—and is now maintaining—its population close to its carrying capacity? Explain how you can tell. [1]

Key
——— Population size
– – – – – Food production/acre



Human Activities and the Loss of Diversity

Some human activities that destroy habitats and degrade ecosystems do far more than damage individual organisms. They also destroy diversity in both the living and nonliving parts of the environment. For example, when humans use land to build a parking lot, the organisms that lived on that land are likely to die. Other organisms that ate the plants, burrowed through the ground, or nested in the nearby trees are also affected. There will be fewer resources available for a variety of species.

Many deliberate human activities, such as clearing land to plant a single crop, can change the equilibrium in an ecosystem. So can some accidents, such as inadvertently or unknowingly adding a species to an ecosystem.

Direct Harvesting The destruction or removal of species from their habitats is known as **direct harvesting.** It can sometimes lead to the extinction of a species. For example, some species that live in distant parts of the world (rain forests or deserts) are removed from their native habitats and sold to people who want them as unusual pets, ornaments, or house or garden plants. That cute monkey or beautiful parrot in the pet shop may not have been born in captivity. Instead, it may have been captured in the wild and shipped here. Many animals die in the process.

Other organisms are killed to collect a specific body part. For example, baby harbor seals are killed for their pelts, and elephants are killed for the ivory in their tusks, which people carve into jewelry or other trinkets. Direct harvesting can threaten the existence of the entire population of a species. Due to over-harvesting, some species of plants and animals have been taken from their native habitats in such large numbers that those species are now endangered. So many whales have been slaughtered that some species are now in danger of extinction.

In the past, humans have caused the extinction of several species. For example, in the early 1800s, billions of passenger pigeons lived in

Figure 7-5. The passenger pigeon: The passenger pigeon, once present in huge numbers, is now extinct because of uncontrolled hunting.

North America. (See Figure 7-5.) Each year hunters shot millions, until the population was greatly reduced. By the time people realized that the species was endangered, it was too late to save it. The last passenger pigeon died in a zoo in Cincinnati, Ohio, in 1914. Today, some endangered species are protected by law. However, because there may be a demand for products made from endangered species, poaching (illegally capturing or killing an organism) is a continuing problem.

Land Use As human populations grow, we use more resources to make the things we need or want, such as clothes, homes, refrigerators, MP3 players, and cars. We also need more space for places to live. More land is needed to grow food, to build roads and factories, and even to provide parks and recreational areas. As human populations and needs increase, our use of land decreases the space and resources available for other species.

Habitat Destruction Many people think that when a habitat is destroyed, the organisms simply find a new home. However, because other parts of the ecosystem are already occupied, displaced animals seldom find a new place to live. Habitat destruction occurs when people take over land for their own use. It is an important way that species can become endangered. They simply have nowhere to live! As habitats are destroyed, whole ecosystems can be damaged and entire species may become extinct. For example, pandas are endangered today because humans have greatly reduced the size of their habitat.

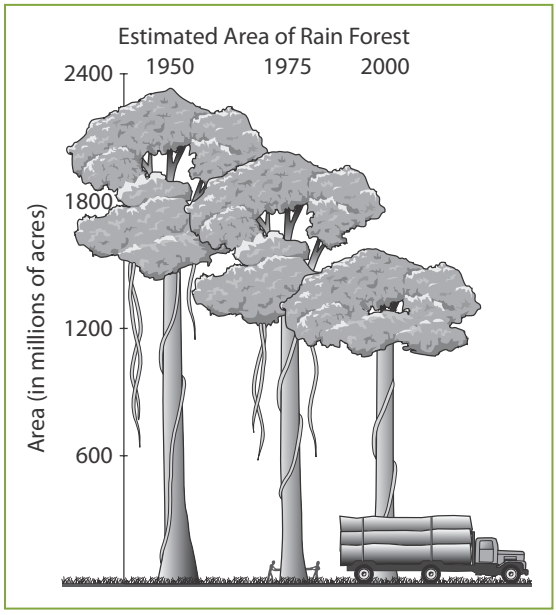


Figure 7-6. Habitat destruction: The destruction of rain forests, an example of deforestation, eliminates many ecosystems.

Deforestation, or the destruction of forests resulting from human activity, is a land use decision that causes widespread habitat destruction. People clear the forest by burning or cutting down the trees. Deforestation can provide people with land for farming and places to live. It also provides resources to use in building or manufacturing. Due to deforestation, the area covered by the world's rain forests is only about half as large as the area covered 150 years ago. (See Figure 7-6.) The wetlands, fields, and forests of New York are also threatened by development.

Biodiversity When a wide variety of different species live together in an ecosystem, it is said to have biodiversity. A reduction in biodiversity occurs when species are lost. This lost biodiversity can affect the health of whole ecosystems and food webs. It can even affect the proportion of gases in the atmosphere. Our future ability to find new medicines for treating diseases or to discover new sources of genes that could be genetically engineered into more productive and pest-resistant crops is threatened when biodiversity is lost.

Habitat destruction, such as deforestation, can lead to loss of biodiversity, but it is not the only way that human activities threaten biodiversity. For example, a farmer might plow under a meadow that is home to many species. Then the farmer might plant a single crop, such as corn or wheat, on many continuous acres of land. This practice greatly reduces the biodiversity of the area. (See Figure 7-7.) In addition, it creates an ideal environment for insects that feed on that crop. To control the insects, the farmer may need to use pesticides, which could harm other organisms living in the same or nearby environments.

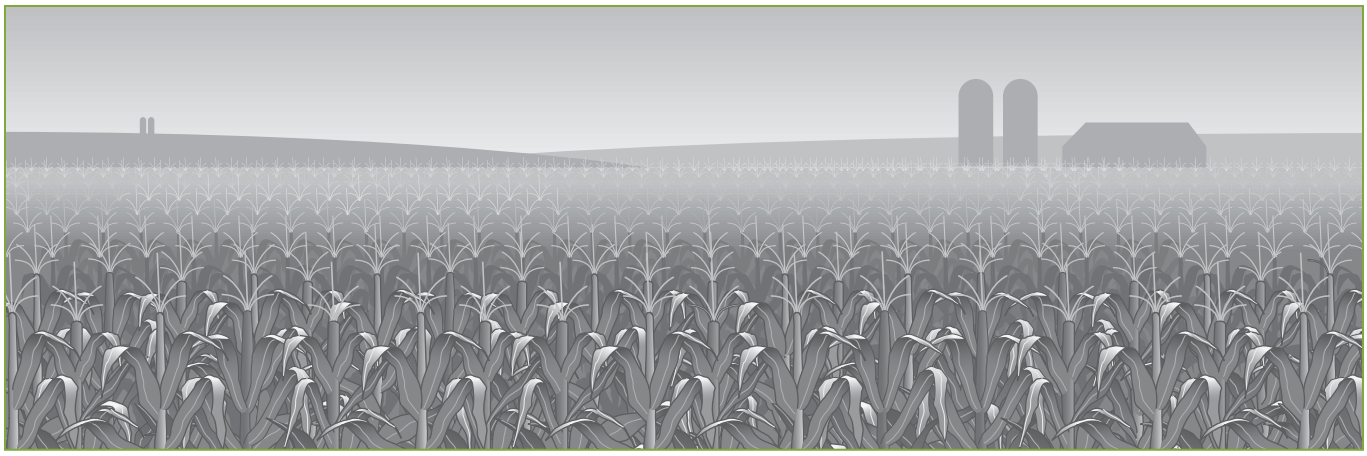


Figure 7-7. Loss of biodiversity: The corn in this field provides habitats for only a few species. The meadow that once grew here was home for hundreds of species of flowers, shrubs, trees and small animals such as insects, mice, and birds.

Imported Species Biodiversity is often reduced when people import and release a species from one environment into another. The release may be inadvertent or intentional. For example, before 1859, there were no rabbits in Australia. Then two dozen rabbits were released in Australia. By 1953, more than a billion rabbits occupied 1.2 million square miles of the continent. These rabbits ate massive amounts of vegetation ordinarily available to the native species.

Many species become pests when they are added to a new environment. Because the new organisms are not part of an existing food web in the area, they often have no natural enemies in their new environment and rapidly overpopulate the area. They then crowd out, feed on, or otherwise eliminate native species. Two examples are Japanese beetles and gypsy moths, which were accidentally released in the U.S. (See Figure 7-8.) Now they are serious pests in New York.

Once an imported species becomes a pest, it is very difficult to solve the problem. If another species is imported to control it, the second species may choose to feed on native organisms, adding another problem. Using pesticides or poisons can kill other organisms in addition to the imported one. Sometimes scientists find a disease organism that only affects the imported species. The rabbits that overran Australia were eventually controlled by a disease organism. However, there is always a risk that the species may become resistant to the disease and overpopulate again.

Because imported species are such a problem, many states and countries have laws to restrict the transport of fruits and vegetables. The goal of these laws is to avoid introducing diseases or insects that might damage local crops. Some countries require the quarantine (confined isolation) of certain animals and plants until officials are sure they are free of any pests that could escape into the new environment.

Scientists are working to find safer methods of pest control. One safe pest control method is setting traps that use chemical scents to attract insects. With this method, no other species are harmed and the population of the pest species can be reduced to a safe level. Breeding and releasing native predators of a pest species has also sometimes been used successfully and without harm to other species.

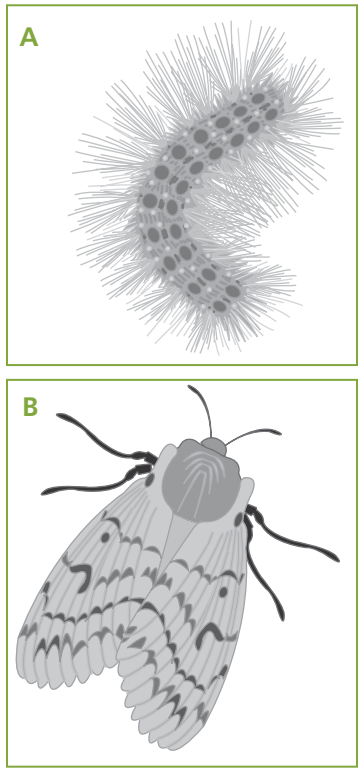


Figure 7-8. Imported species: (A) During the larval stage, the gypsy moth consumes vast quantities of leaves. (B) The adult moth lays hundreds of eggs, continuing the problem.

6. Ladybugs were introduced as predators into an agricultural area of the United States to reduce the number of aphids feeding on grain crops. This action is an example of

(1) preservation of endangered species
(2) conservation of natural resources
(3) protection of watershed areas
(4) use of a nonchemical means of pest control

7. An example of a human activity that has had a positive effect on the environment is the

(1) disruption of natural habitats through deforestation
(2) capture and sale of rare South American birds
(3) use of reforestation to control erosion in the mountains
(4) hunting of endangered species of animals

8. The trees in a forest aid in reducing flood damage chiefly because their

(1) branches store water in the form of sap
(2) leaves absorb moisture from the air
(3) root systems hold the soil in place
(4) stems serve to store food

9. The creation of wildlife refuges and the enforcement of game laws are conservation measures that promote increased

(1) use of chemicals to control pests
(2) preservation of species
(3) use of natural controls to limit pest populations
(4) exploitation of wildlife species

10. When land is cleared for agriculture or home construction, small isolated sections of the original habitat may remain. Explain how this reduction in habitat size and the isolation of small sections of habitat might lead to species endangerment. [1]

11. A method of agriculture presently used throughout the world where one crop is grown on many acres of land has created serious insect problems. This is primarily because this method

(1) increases soil erosion
(2) provides concentrated areas of one kind of food for insects
(3) increases the effectiveness of insecticides used over long periods of time
(4) involves the growing of crops in former desert areas

12. The least ecologically damaging method for controlling the mosquitoes that spread the diseases malaria and encephalitis is by

(1) draining the swamps where mosquitoes breed
(2) spraying swamps with chemical pesticides
(3) spreading oil over swamps
(4) introducing local fish species to the swamps where mosquitoes breed

13. Many people place bat boxes on their property to provide housing that attracts insect-eating bats. Explain how this activity has a positive effect on the environment. [1]

14. In 1859, a small colony of 24 rabbits was brought to Australia. By 1928 it was estimated that there were 500 million rabbits in a 1-million square mile section of Australia. Which statement describes a condition that probably contributed to the increase in the rabbit population?

(1) The rabbits were affected by many limiting factors.
(2) The rabbits reproduced by asexual reproduction.
(3) The rabbits were unable to adapt to the environment.
(4) The rabbits had no natural predators in Australia.

15. Humans are responsible for some of the negative changes that occur in nature because they

(1) have controlled the use of many pesticides and other environmentally damaging chemicals
(2) have passed laws to preserve the environment
(3) are able to preserve scarce resources
(4) are able to modify their physical environment to provide for human needs

16. Which of the following human activities would be the most likely to prevent certain species from becoming extinct?

(1) Pass laws to place all endangered species in zoos.
(2) Increase the hunting of predators.
(3) Increase wildlife management and habitat protection.
(4) Mate organisms from different species to create new and stronger organisms.

17. In the Cochella Valley in California, much of the desert has been converted into golf courses, housing developments, and hotels. The habitat of the Cochella Valley fringe-toed lizard is rapidly being lost. This lizard is adapted to life on fine, windblown sand. Environmentalists want to save the lizard, and developers want to continue construction. Which action would be the best long-term solution?

(1) Land in the Cochella Valley should be purchased and set aside as a preserve for the lizards.
(2) The fringe-toed lizards should be crossed with a species adapted for survival in a different habitat.
(3) The land should be developed as planned and the lizards relocated to a different valley.
(4) The land should be developed as planned and the lizards monitored to see if they can adapt to the new conditions.

18. Refer to the chart below, which illustrates some methods of pest control.

Methods of Insect Pest Control
Insect pests can be repelled or attracted with sex hormones.
Insect populations can be controlled by releasing males sterilized with X-rays.
New plant varieties can be produced and grown that are resistant to insect pests.
Insect pests can be controlled by introducing their natural enemies.

One likely effect of using these methods of pest control will be to

(1) prevent the extinction of endangered species
(2) increase water pollution
(3) reduce pesticide contamination of the environment
(4) harm the atmosphere

The Impact of Technology and Industrialization

Humans modify ecosystems through population growth, consumption, and technology. As human populations grow, they take up more space, consume more resources, and produce more wastes. The expansion of **technology** (using scientific knowledge and technical processes to meet human needs) also increases the quantity of resources people use. All these activities lead to changes in ecosystems, including the way they function. The equilibrium of stable ecosystems can be upset by human actions.

Industrialization

Industrialization is the development of an economy in which machines produce many of the products people use. These products may add to the quality of life, but their manufacture can harm the environment. In addition to contributing to pollution of the air and water, industrialization increases the demand for energy, water, and other resources, including fossil and nuclear fuels.

Higher energy demands in an industrialized society mean that more power plants must be built. Additional power plants—especially those that burn coal—add to the pollution of our air and water. **Nuclear fuel** is an energy source that results from splitting atoms. Nuclear power plants do not pollute the air or water with toxic chemicals, but they can cause thermal pollution of waterways. Also, the disposal of radioactive nuclear wastes presents a huge environmental problem.

Another problem with increased industrialization is that most factories use a lot of water. Large wells drilled for factories sometimes dry up the nearby smaller wells that individuals use to supply their homes. In some cases, withdrawing large quantities of water causes the ground to collapse, forming sinkholes. In dry climates, reducing the supply of groundwater can have serious consequences for native plants and the consumers that depend on them for food.

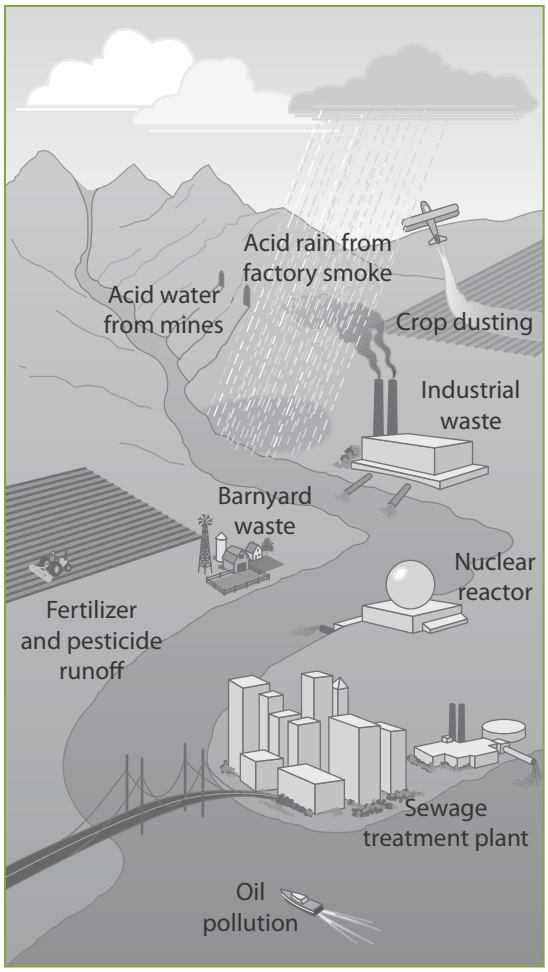


Figure 7-9. Water pollution: Water pollution, which can damage an ecosystem, comes from many sources.

Just as conservation (the three R's) can help preserve our resources, it can also help to limit the negative impact of industrialization. We can REDUCE our demand for energy and manufactured goods that we don't really need. We can REUSE manufactured products rather than discard them, and we can RECYCLE as many products as possible, conserving both energy and resources in the process.

Water Pollution

Rivers, lakes, and oceans are easy places for people to dispose of wastes, including sewage, wastes from homes and factories, and animal wastes from farms. The addition of pollutants to natural environments causes water pollution, which can change the abiotic conditions in ecosystems. For example, sewage and animal wastes can act as fertilizer, increasing the growth of plants, algae, and bacteria in aquatic systems. Plants consume oxygen all the time, day and night. However, photosynthesis, the primary source of oxygen, stops at night because it requires light. As a result, oxygen production also stops. Then, oxygen levels drop and many organisms suffocate. When these organisms die, oxygen-using decomposers begin their decay activity, which further decreases the oxygen supply. Eventually, all the organisms in this oxygen-reduced ecosystem may be lost. Figure 7-9 shows several ways water pollution can affect a natural habitat.

Toxic Wastes Many wastes dumped into waterways from cities, farms, or industries can be toxic (poisonous) to the organisms that use or live in the water. Chemical fertilizers and weed and insect killers can be washed off farmlands into streams or rivers. The chemicals can collect in the cells of organisms living in the water and along the shore. These toxic materials then move through the food chain and eventually damage or kill many kinds of organisms.

Although the level of toxic substances in the water might be low, scientists have learned that the concentration of a toxin increases as it moves through the food chain. For example, small quantities of toxic substances are absorbed into the cells of algae and other producers living in the water. When those producers are eaten by small herbivores, the toxins are stored in the herbivore's fatty tissue. There it stays until the herbivore is eaten by the next consumer in the food chain. At each level of the chain, larger and larger amounts of toxic material collect in the fatty tissue. Organisms at or near the top of the food chain are most likely to accumulate enough of these chemicals in their bodies to cause them harm. (See Table 7-2.)

For example, farmers used to spray the pesticide DDT on their crops. Rain washed some of the DDT off the land and into streams and rivers. In the water, the DDT moved up through the food chain. Soon, fish-eating birds at the top of the food chain produced eggs with very thin shells. The shells were so thin that they broke easily, which killed the next generation of birds before it even hatched.

Table 7-2. Accumulation of a Toxic Substance by Organisms in a Food Chain				
Food Chain Organisms	Plant —>	Herbivore —>	Carnivore 1 —>	Carnivore 2
Relative concentration of the toxic substance	.000003	0.04	0.5	2.0
Magnification factor (compared to the amount in the plant)	0	1,333 times as much	16,667 times as much	66,667 times as much

Thermal Pollution Some power plants and industries use water to cool their machines or materials. The warmed water is then released into a river or lake, and the water temperature in the river or lake rises. Because warm water cannot hold as much dissolved oxygen as cold water, the oxygen level in the river or lake drops as the water temperature rises. Some species may suffocate as a result of thermal pollution; others may be forced to try to find a new home.

The solution to most of these problems is to find better ways to deal with wastes and to reduce the need for power. Sewage can be treated before it is discharged into waterways. Toxic wastes can be separated from other materials and either recycled or stored safely. People could conserve energy by using less power. Methods could be developed for cooling industrial processes that would reduce their damage to the environment.

Air Pollution

Just as wastes dumped into rivers and oceans cause water pollution, harmful substances released into the air cause air pollution. Early in the industrial age, people thought that burning wastes just disappeared into the atmosphere, and that they didn't have to worry any more about the wastes. We now know this is not true! Most of the pollutants released into the atmosphere eventually wind up in the water cycle and return to the water or land. Like water pollution, air pollution can damage habitats and harm the organisms that live in them. Figure 7-10 shows how air pollution can affect a natural habitat.

Burning Fossil Fuels Fuels such as the coal and gas that formed from the remains of organisms that lived millions of years ago are known as **fossil fuels.** Factories, cars, and most electrical power-generating plants burn fossil fuels. When fossil fuels are burned, carbon dioxide and other gases—some containing sulfur and/or nitrogen—are added to the air.

Acid Precipitation Sulfur and nitrogen compounds that are produced when fossil fuels burn can combine with moisture in the atmosphere. When this moisture falls to Earth as acid rain, snow, or other precipitation, it has a low pH level and is much more acidic than normal precipitation. Some acid precipitation can be as acidic as lemon juice. When highly acidic rain or snow touches plants, it may damage them and disrupt the way they function. The damaged plants may be more susceptible to attacks by fungi or insects.

Acid precipitation can also fall into lakes and streams or run off the land into the water. In lakes, the lower pH levels can be deadly to algae, the eggs of some fish, and other organisms. Producer organisms, such as algae, are killed. Without algae suspended in it, the water looks crystal clear and pure. However, the food chains in the ecosystem have been disrupted, and

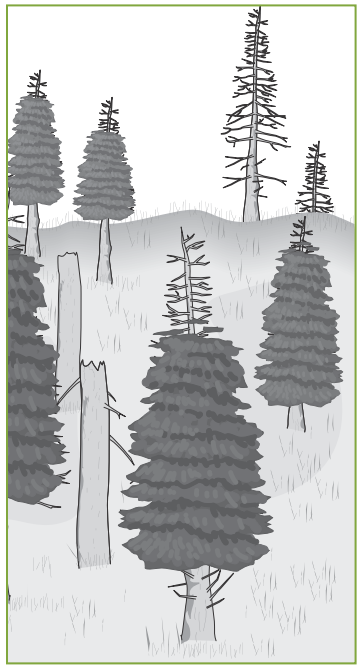


Figure 7-10. Air pollution: Trees can be damaged—or killed—by polluted air.

populations of fish and other organisms have died. Some lakes have become so acidic that nothing can live in them.

Smog Other air pollutants are produced by automobile exhaust and by industrial processes. Some of these pollutants can be toxic when inhaled. This kind of pollution becomes more serious when weather conditions trap the gases in an area for hours or even days. Smog is a kind of air pollution that results when certain pollutants react with sunlight. It looks like a gray or brown haze and contains many airborne pollutants. People with respiratory diseases are especially sensitive to air pollution and may be in danger when air pollution is intense.

Global Atmospheric Changes

Some pollutants in the air harm living things directly, like the trees in Figure 7-10. Others can cause worldwide atmospheric changes that threaten many habitats and the organisms that live in them.

Global Warming Sunlight passes through the gases in the atmosphere to reach Earth. But some of these atmospheric gases, called greenhouse gases, also trap and absorb the infrared radiation that bounces off Earth's warmed surface. For thousands of years, this process—called the greenhouse effect—has kept Earth warm. In recent years, however, the amount of greenhouse gases in the atmosphere has increased. As Figure 7-11 shows, the increased amount of greenhouse gases in Earth's atmosphere traps some of the heat that would normally radiate into space. The result is that Earth's average temperature is rising. This increase in temperature, called **global warming,** could lead to changes in climate patterns and even to the melting of the ice caps at the North and South Poles. Most of the recent increase in greenhouse gases has been caused by burning fuel for transportation and industry.

Carbon dioxide, a major greenhouse gas, is released when fossil fuels are burned. (See Figure 7-12.) If the greenhouse effect causes climate change, the world's food supply may suffer. Another effect could be that the ice

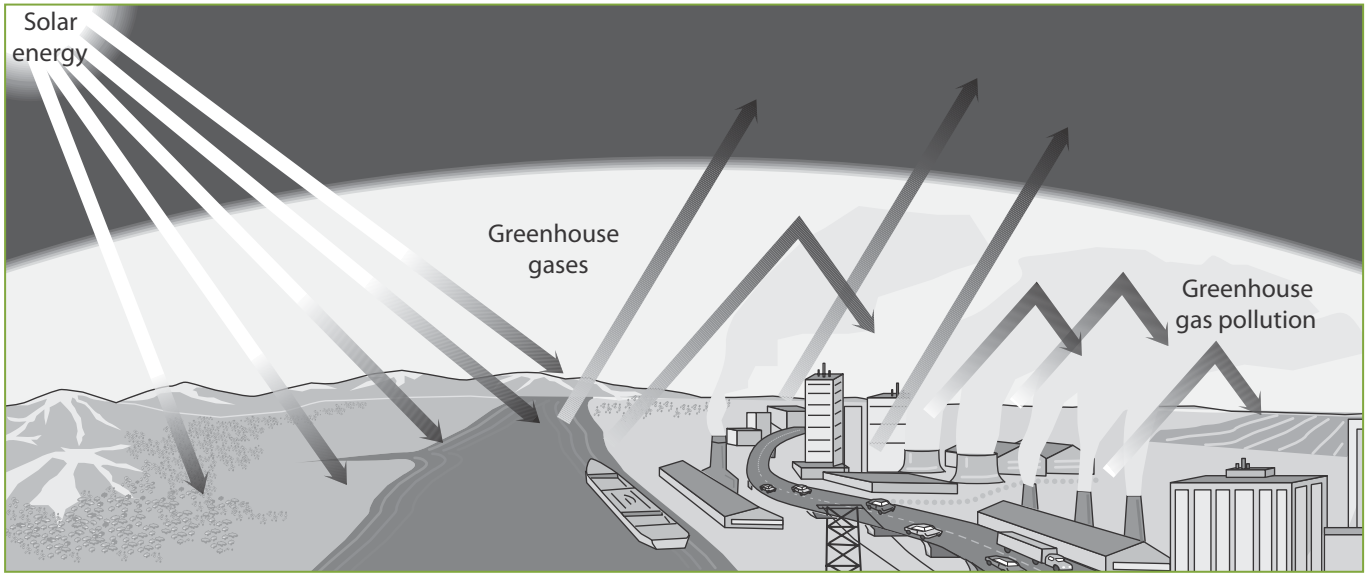


Figure 7-11. Global warming: Pollution caused by human activity is increasing the amount of greenhouse gases in the atmosphere. This increase can intensify the greenhouse effect, causing global warming.

caps could melt, leading to a rise in sea level and flooding in many coastal habitats.

Finding and using energy sources that do not add carbon dioxide to the atmosphere is one way to prevent further global warming. Because trees remove large quantities of carbon dioxide during photosynthesis and store it in their tissues as carbon compounds, growing more long-lived trees could also help solve the problem.

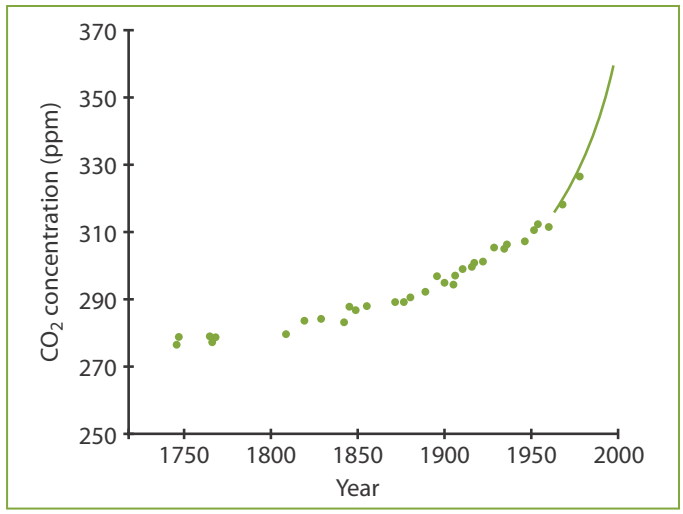


Figure 7-12. Carbon dioxide in the atmosphere from 1750 to 2000: The amount of carbon dioxide in the atmosphere has increased greatly since the beginning of the Industrial Revolution. The dots are data from ice core samples; the solid line represents direct measurements.

Ozone Depletion Ozone depletion is another atmospheric problem that we must solve. Like global warming, ozone depletion is a worldwide problem, and international cooperation is needed to find an effective long-term solution.

The release of certain industrial gases into the atmosphere has led to destruction of much of the **ozone shield,** the layer of ozone gas in the upper atmosphere that protects Earth from some of the sun's radiation. (See Figure 7-13.) The thinning "hole" in the ozone shield allows above normal amounts of ultraviolet radiation from the sun to reach Earth's surface. Ultraviolet radiation can cause genetic mutations and can kill cells that are exposed to it. An increase in ultraviolet radiation at Earth's surface could result in more cases of skin cancer. It could also destroy many of the producer organisms in the oceans. This would disrupt food chains and reduce the amount of oxygen released by the producers.

The main cause of ozone depletion is the release of gases called chlorofluorocarbons, or CFCs, into the atmosphere. CFCs have been used as coolants in refrigerators and air conditioners, as propellants in aerosol cans, and in the manufacture of plastic foam. Some steps have been taken to reduce the release of these gases. Researchers have found alternatives to the products that cause the most damage, and international agreements to reduce emissions of the harmful gases have been made.

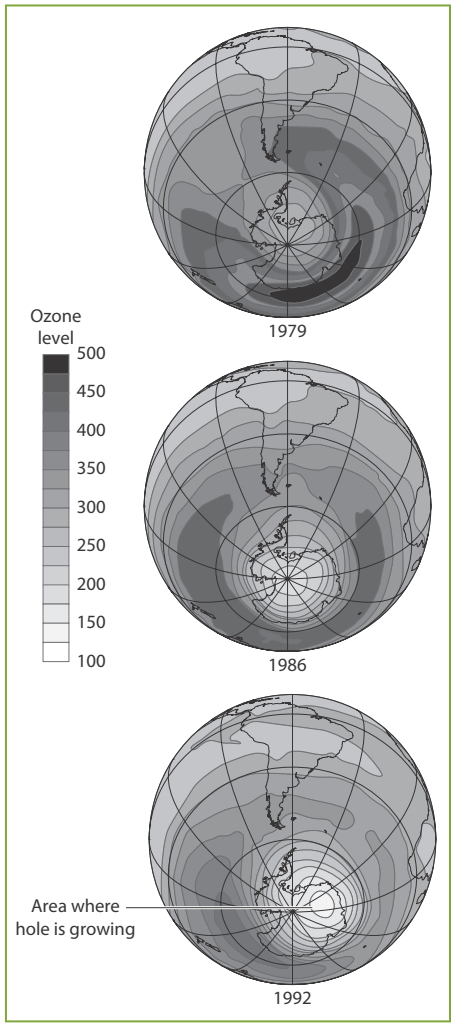


Figure 7-13. The "hole" in the ozone shield: These satellite maps show how much the "hole" in the ozone shield above the South Pole grew in just over a decade.

Individual Choices and Societal Actions

Many people hope technology will help solve some of our environmental problems. In fact, technology has led to some improvements. For example, advances in technology have allowed farmers to greatly increase the crop yield of an acre of land. Larger crop yields mean a greater supply of food. However, some kinds of technology, such as pesticides and fertilizers, can cause pollution and have other harmful effects on the environment.

If technology cannot solve all our environmental problems, people will need to take some difficult steps to save our ecosystem. For some problems, solutions are now available, but they affect our quality of life. For example, we know how to reduce the air and water pollution caused by factories, power-generating plants, and automobiles, but the solutions are expensive and would make the

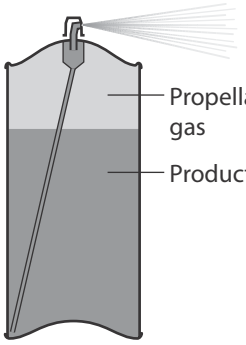


Figure 7-14. CFCs: Aerosol cans no longer use ozone-destroying CFCs as propellants. Safer alternatives have been found.

products we buy cost more. We also know how to conserve energy, but many people are unwilling to give up their large cars, brightly lit neighborhoods, and air-conditioned comfort and to turn off their radios, computers, and televisions.

For each environmental problem, people must learn to assess the risk to the ecosystem. For each solution, they must learn to analyze the costs and benefits. Then they must determine which **trade-off,** or compromise, is acceptable and which is simply too dangerous to the welfare of future generations.

The Impact of New Technologies

New laws restrict the introduction of certain new technologies or major construction projects. The individual or company seeking permission to make a change that affects the environment must prepare a statement known as an environmental impact statement. This statement includes an analysis of how the project or technology will affect the environment and is usually discussed at public hearings. Then members of the public or their elected representatives vote on whether or not to allow the new technology or construction project to go forward. Appropriate decisions can be made only if the public is environmentally literate and has a clear understanding of the ecological issues. If an incorrect decision is made, it may be impossible to undo the damage that might result.

Figure 7-15. Public hearings: Discussion can be held to consider environmental issues and the trade-offs involved.

Today's Decisions Affect the Next Generation

The decisions we make today can have a huge impact on our environment. Those decisions, right or wrong, will affect the people living today as well as future generations.

The loss of some species may seem unimportant. However, the loss of that single species might have a huge impact on the ecology of an area. If the loss of species continues, large-scale destruction of natural environments will result, with serious consequences for the future. For example, the destruction of large forests or the loss of algae in ocean waters affects not only the organisms that live in those ecosystems but organisms elsewhere too. Those losses may compromise Earth's ability to produce enough oxygen and remove enough carbon dioxide to maintain an atmosphere that meets the needs of all of its inhabitants, including humans.

Many important decisions about the environment are made by states and nations, but a surprising number of important decisions are made each day by individuals. For example, individuals decide whether to burn their garden waste or turn it into compost, whether to toss the soda can into the trash or recycle it, whether to grab a fresh sheet of paper or write a note on an old envelope.

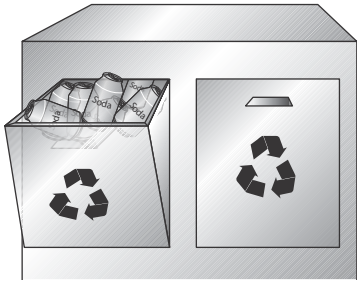


Figure 7-16. Recycling: Decisions on recycling are made by individuals and their communities.

Much of the impact of our technology and population growth on Earth's ecosystems has been detrimental. If our environmental problems are not recognized and solved, the long-term damage will be irreversible and severe. On the other hand, cooperation by individuals and nations can help maintain the stability of the ecosystems upon which all life depends. Making people aware of the successful results of the collective actions of many separate individuals may be the most promising approach to solving ecological problems.

19. Car exhaust has been blamed for increasing the amount of carbon dioxide in the air. Some scientists believe this additional carbon dioxide in the air may cause

(1) global warming
(2) increased biodiversity
(3) habitat preservation
(4) ozone destruction

20. Deforestation will most directly result in an immediate increase in

(1) atmospheric carbon dioxide
(2) atmospheric ozone
(3) wildlife populations
(4) renewable resources

21. Which human activity has probably contributed *most* to lake acidification in the Adirondack region of New York State?

(1) passage of environmental protection laws
(2) reforestation projects in lumbered areas
(3) production of chemical air pollutants by industry
(4) use of biological insect controls to eliminate pests

22. A major reason that humans can have such a significant impact on an ecological community is that humans

(1) can modify their environment through technology
(2) reproduce faster than most other species
(3) are able to increase the amount of finite resources available
(4) remove large amounts of carbon dioxide from the air

23. Explain how the runoff waters from farm land and golf courses might be dangerous to organisms living in ponds, rivers, or streams. [1]

24. Explain why water shortages occur frequently in parts of New York State even though the water supply is nearly constant. [1]

25. The number of industries along New York State's rivers is increasing. What is the most likely consequence of increased industrialization?

(1) a decrease in the amount of water needed by industry
(2) a decrease in the amount of water pollution
(3) an increase in the destruction of natural ecosystems
(4) an increase in the amount of water available for recreational use

26. Which statement illustrates how human activities can most directly change the dynamic equilibrium of an ecosystem?

(1) A hurricane causes a stream to overflow its banks.
(2) Increased wind increases water evaporation from a plant.
(3) Water pollution causes a decrease in fish populations in a river.
(4) The ozone shield helps prevent harmful radiation from reaching the surface of Earth.

27. Which illustrates the human population's increased understanding and concern for ecological interrelationships?

(1) importing organisms in order to disrupt existing ecosystems
(2) allowing the air to be polluted only by those industries that promote technology
(3) removing natural resources from the Earth at a rate equal to or greater than the needs of an increasing population
(4) developing animal game laws in order to limit the number of organisms that may be killed each year

28. When living organisms obtain water and food from their environment, they may also take in toxic pesticides. Low concentrations of some pesticides may not kill animals, but they may damage reproductive organs and cause sterility. The data table below shows concentrations of a pesticide in tissues of organisms at different levels of a food chain.

Concentration of Pesticide in Tissues

Organisms	Pesticide Concentration (parts per million)
producers	0.01 — 0.03
herbivores	0.25 — 1.50
carnivores	4.10 — 313.80

What does this information suggest to a person who is concerned about health and is deciding on whether to have a plant-rich or an animal-rich diet? Support your answer using the information provided. [1]

Practice Questions *for the* New York Regents Exam

Directions

Review the Test-Taking Strategies section of this book. Then answer the following questions. Read each question carefully and answer with a correct choice or response.

Part A

1 Today's lifestyles have led to increased demands for disposable products. The packaging of these products has caused environmental problems most directly associated with
(1) food web contamination
(2) atmospheric depletion
(3) solid waste disposal
(4) the use of nuclear fuels

2 Some modern agricultural methods have created serious insect problems, primarily because these methods
(1) increase soil loss
(2) provide concentrated areas of food for insects
(3) aid in the absorption of water
(4) grow crops in areas where formerly only insects could live

3 The decline and extinction of many predatory animal species is most probably the result of
(1) an overabundance of prey species
(2) the introduction of a new species of animal into an area
(3) the disruption of natural food chains
(4) the decreased use of chemical pesticides

4 Modern methods of agriculture have contributed to the problem of soil depletion because many of these methods
(1) require smaller amounts of mineral and fertilizer application
(2) interfere with the natural cycling of elements
(3) use many varieties of cloned plants
(4) depend on the practice of planting and harvesting

5 Which action that humans have taken in attempting to solve an ecological problem has had the most negative effect?
(1) seeking better means of birth control in the human population
(2) applying scientific farming techniques to oceans
(3) producing stronger and more effective pesticides
(4) developing new techniques for the disposal of sewage and industrial and chemical wastes

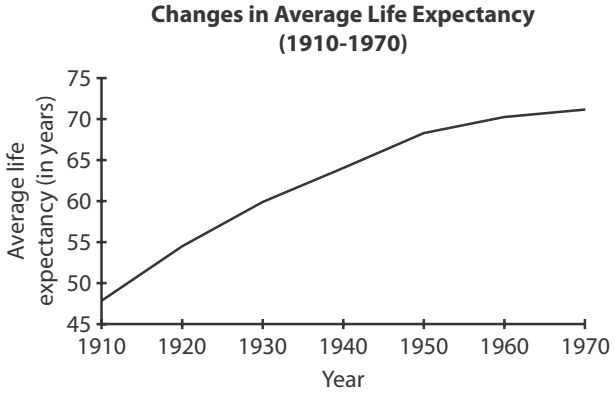
6 Japanese beetles, a major insect pest in the United States, do relatively little damage in Japan because they
(1) are kept in check by natural enemies
(2) are kept in check by effective pesticide sprays
(3) hibernate during the winter months
(4) have gradually adapted to the environment

7 Gypsy moths were accidentally introduced into North America. The most probable reason these insects have become serious pests in North America is that they
(1) were bred by research scientists and are resistant to all pesticides
(2) are protected by environmental laws and feed on other insect species
(3) have few natural enemies and reproduce successfully
(4) are affected by natural controls and feed on plants

8 The survival of many plants and animals has been aided most by
(1) increasing the height of industrial smokestacks to spread air pollutants away from the immediate vicinity of combustion
(2) reduction in the number of restrictive pollution control laws
(3) heavy use of pesticides to kill all of the insect pests that compete with humans for food sources
(4) development of research aimed toward the preservation of endangered species

9 DDT is an insecticide that accumulates in the fatty tissues of animals and is transferred through food chains. Its concentration increases at each link of a food chain. Which organism in a food chain is most likely to accumulate the highest concentration of DDT?
(1) rabbit (a herbivore)
(2) corn (a producer)
(3) field mouse (a consumer)
(4) owl (a predator)

10 What is the most likely cause of the change in life expectancy shown in the graph below?



(1) poor land-use management that has affected the quality of the topsoil
(2) technological oversights that have had an impact on air quality
(3) a decrease in natural checks, such as disease, on the population
(4) widespread use of pesticides, such as DDT, in water supplies

11 As water flows downhill, its energy can be used to generate electricity. Later, this water may evaporate, fall as rain, and be used again to generate electricity in the same way. This explains why electricity generated with water is considered
(1) a source of water pollution
(2) a renewable form of energy
(3) more expensive than nuclear energy
(4) responsible for global warming

Part B

Base your answers to questions 12 through 15 on the passage below and on your knowledge of biology.

Keystone Species

A keystone species is one whose presence contributes to the diversity of life and whose extinction would lead to the extinction of other forms of life. A keystone species helps to support the ecosystem of which it is a part.

An example of what can happen when a keystone species is removed occurred when fur hunters eliminated sea otters from some Pacific Ocean kelp beds. Otters eat sea urchins, which eat kelp. With its major predator gone, sea urchin populations exploded and consumed most of the kelp. Fish, snails, and other animals associated with the kelp beds disappeared.

The grizzly bear is another example of a keystone species. Grizzlies transfer nutrients from the ocean ecosystem to the forest ecosystem. The first stage of this transfer is performed by salmon that swim up rivers, sometimes for hundreds of miles. Salmon are rich in nitrogen, sulfur, carbon, and phosphorus. The bears capture the salmon and carry them onto dry land, scattering nutrient-rich feces (wastes) and partially eaten salmon carcasses. It has been estimated that the bears leave up to half of the salmon they harvest on the forest floor.

12 One action humans can take that might ensure that these sea otters will continue their function as a keystone species in their environment is to
(1) establish a sea otter wildlife refuge in the Atlantic Ocean
(2) pass laws to regulate the hunting of sea otters
(3) plant kelp in the Pacific Ocean
(4) destroy sea urchins found living in the kelp beds

13 Some people feel the grizzly bear should be eliminated from parts of its natural range. Describe the impact of this proposed action on the forest ecosystems in these areas if the bears are eliminated. Support your answer with information from the passage. [1]

14 Which organism is most likely *not* functioning as a keystone species in its ecosystem?

(1) beaver — transforms its territory from a stream to a pond or swamp, maintaining the habitat for a variety of native species

(2) elephant — destroys trees, making room for grass species and preventing the environment from becoming a woodland

(3) black-tailed prairie dogs — burrows act as homes to other creatures, including burrowing owls, badgers, rabbits, snakes, salamanders, and insects

(4) zebra mussels — compete with native species, reducing the biodiversity of the Great Lakes ecosystem

15 Which sequence best represents the feeding relationships in a kelp ecosystem that has not been disturbed by humans?

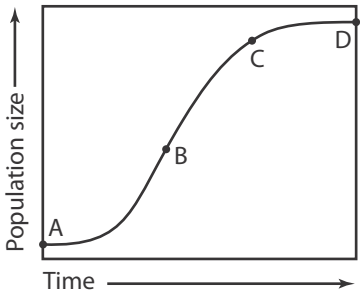
(1) sea urchins → kelp → fish

(2) kelp → sea urchins → sea otters

(3) kelp → sea otters → sea urchins

(4) sea urchins → snails → kelp

Base your answers to questions 16 through 19 on the diagram below and on your knowledge of biology. The diagram represents the growth rate of a mouse population introduced into an abandoned field ecosystem.



16 At what points is food most likely a limiting factor in the rate of mouse population growth?

(1) A and B (3) C and D

(2) B and C (4) B and D

17 At what point is the rate of population growth the greatest?

(1) A (2) B (3) C (4) D

18 At what point would the mouse population be the greatest in the ecosystem?

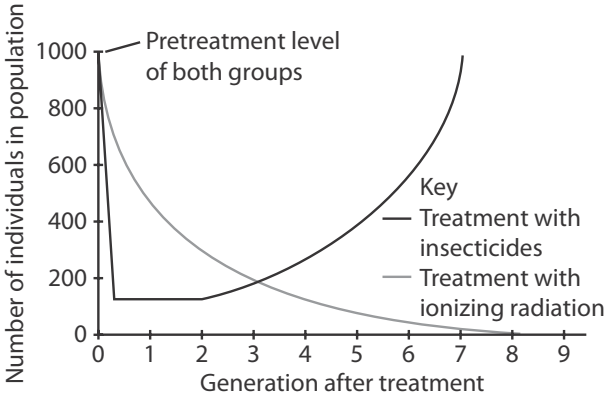
(1) A (2) B (3) C (4) D

19 Compare the growth rate of the mouse population in the abandoned field to the growth rate of the human population. In your comparison be sure to identify

- how it is similar [1]
- how it is different [1]

Base your answers to questions 20 and 21 on the information and graph below and on your knowledge of biology.

The screw-worm fly is a destructive parasite of livestock. The graph shows the results of an experiment in which one population of screw-worm flies was treated with pesticides and another group of equal size was treated with ionizing radiation, which made the male flies sterile.



20 At what point after treatment will the group treated with pesticide probably reach its pretreatment population?

(1) first generation (3) third generation

(2) seventh generation (4) eighth generation

21 At what point after treatment will the sterility method be more successful against screw-worm flies than the pesticide method?

(1) immediately (3) third generation

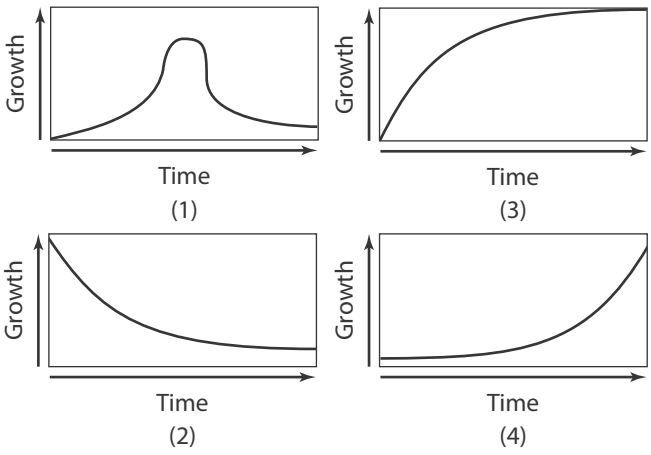
(2) second generation (4) sixth generation

Base your answers to questions 22 and 23 on the information in the paragraph below and on your knowledge of biology.

A single protist (a one-celled organism) was placed in a large test tube containing nutrient broth. The tube was kept at room temperature for 24 hours. Samples from the tube were observed periodically during the 24 hours, using the low power of a compound light microscope. The data are summarized in the table below.

Age and Number of Protists in Culture	
Age of the Population in Hours	**Number of Protists in the Population**
0	1
6	2
8	3
10	4
13	8
16	16
18	32
20	64
22	128
24	256

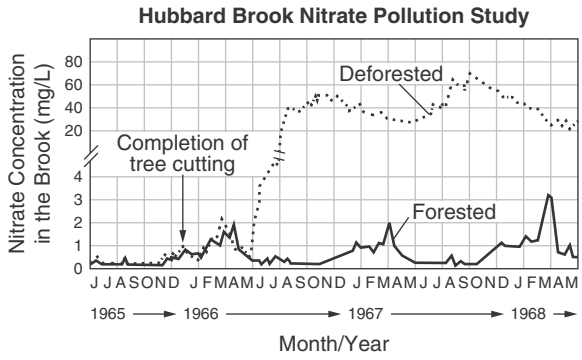
22 Which graph best represents the data given in the table?



23 Which graph most resembles the growth of the human population at the present time?

(1) 1 (2) 2 (3) 3 (4) 4

Base your answers to questions 24 and 25 on the graph below which shows pollution from nitrogen-containing compounds (nitrates) in a brook flowing through a deforested and a forested area between 1965 and 1968.



24 State how nitrate pollution in the brook changed after the brook flowed through the deforested area. [1]

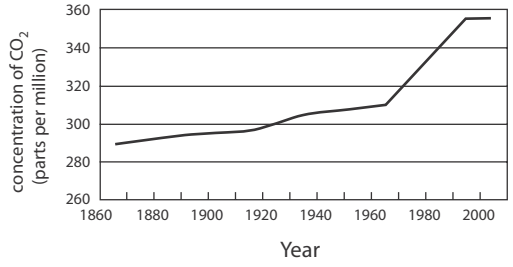
25 Explain how deforestation contributed to this change. [1]

Part C

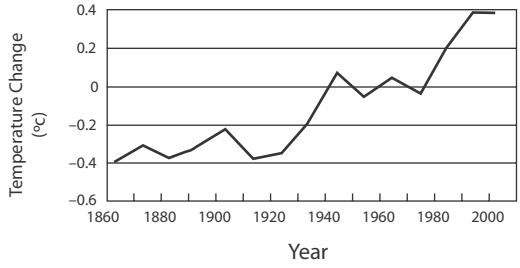
Base your answers to questions 26 through 29 on the information and graphs below, and on your knowledge of biology.

For over 100 years scientists have monitored the carbon dioxide concentrations in the atmosphere in relation to changes in the atmospheric temperature. The graphs below show the data collected for these two factors.

Concentration of Carbon Dioxide in the Atmosphere



Average Atmospheric Temperature Change per Year



26 State the overall relationship between the concentration of carbon dioxide and changes in atmospheric temperature. [1]

27 State one way in which humans have contributed to the increase in atmospheric carbon dioxide. [1]

28 Identify one specific *negative* effect the continued rise in temperature would be likely to have on an ecosystem. [1]

29 Describe one way humans could try to reduce the problem of global warming. [1]

Base your answers to questions 30 and 31 on the information below and on your knowledge of biology.

Cattail plants that grow in freshwater swamps in New York State are being replaced by an imported species of plant called purple loosestrife. The two species have very similar environmental needs.

30 Since cattails and loosestrife occupy the same niche, it is predicted that eventually only one of the two species will exist in New York freshwater swamps. State one reason why loosestrife will probably out-compete the cattails and be more successful. [1]

31 Explain why loosestrife plants replacing the native cattails could potentially cause a decrease in many swamp wildlife populations and perhaps even lead to the elimination of some species from New York State. [1]

---

32 Describe two ways in which the destruction of the rainforest in South America could affect a hospital patient in New York State? [1]

Base your answer to questions 33–35 on the information below, and on your knowledge of biology.

Human activities continue to place strains on the environment. One of these strains on the environment is the loss of biodiversity.

33–35 Explain what this problem is and describe some ways humans are involved in both the problem and the possible solutions. In your answer be sure to:

- state the meaning of the term *biodiversity* [1]
- state one *negative* effect on humans if biodiversity continues to be lost [1]
- suggest one practice that could be used to preserve biodiversity in New York State [1]

Base your answers to questions 36 and 37 on the information below and on your knowledge of biology.

Plankton is the name given to the algae and microscopic life that grow in great numbers on and near the surface of the ocean. Plankton serve as the basis of food chains for oceanic life. Scientists have become concerned with the increase in ultraviolet (UV) radiation reaching the surface of the Earth in recent years. They fear that UV rays may negatively impact the plankton.

36 Explain why the amount of UV radiation reaching the surface may be on the increase, especially near the North and South Poles. [1]

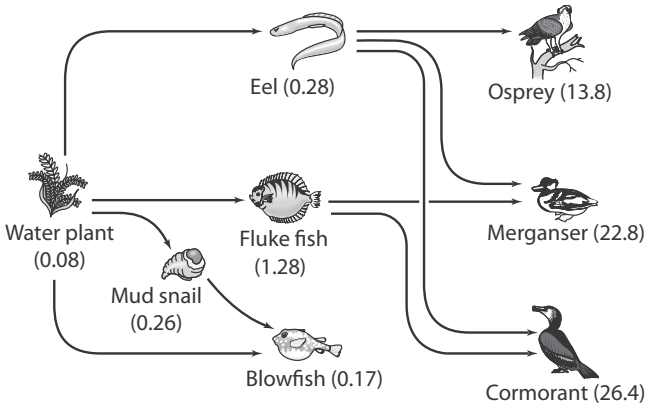
37 Describe the effect any large-scale plankton destruction will have on larger species living in these same areas of the ocean where the UV levels have been increasing. [1]

---

38 Destruction of the ozone shield is generally considered a negative aspect of human involvement with the ecosystem. Explain how solving this problem will require increasing global awareness and cooperation [1]

Base your answers to questions 39 and 40 on the diagram below and on your knowledge of biology. The diagram represents a part of a food web in a Long Island ecosystem.

The numbers in the diagram show the concentration of the insecticide DDT in parts per million (ppm) in the body tissues of the various organisms.



39 Explain why the water plant contains the pesticide DDT. [1]

40 Explain why the amounts of DDT in the three bird species are so much higher than in the other organisms of this food web. [1]

Base your answers to questions 41 through 43 on the information below and on your knowledge of biology.

The planning board of a community held a public hearing in response to complaints by residents concerning a waste-recycling plant. These residents claim that the waste-hauling trucks were polluting air, land, and water and that the garbage has brought an increase in rats, mice, and pathogenic bacteria to the area. The residents were insistent that the waste-recycling plant be closed permanently.

Other residents recognized the health risks but felt that the benefits of waste recycling outweighed the health issues.

41 Identify *two* specific health problems that could result from living near the waste recycling plant. [1]

42 State *one* cause of a health problem that can be associated with the presence of the waste recycling plant. [1]

43 State *one* ecological benefit of recycling wastes. [1]

Base your answers to questions 44–45 on the information below and on your knowledge of biology.

44–45 Ladybugs were introduced as predators into an agricultural area of the United States to reduce the number of aphids (pests that feed on grain crops). Describe the positive and negative effects of this method of pest control. Your response must include at least:

- *two* advantages of this method of pest control [1]
- *two* possible dangers of using this method of pest control [1]

Base your answers to questions 46 through 48 on the information below and on your knowledge of biology.

In the 1980s, global deforestation was estimated at 17 to 20 million hectares per year, an area the size of Great Britain. Today, the area affected by deforestation has decreased significantly in some regions of the world through the use of sustainable forest management. However, there are still regions of the world affected by wide-scale deforestation, because of the short-term economic benefits. The harmful effects of deforestation on regional and worldwide climate and ecology continue as forest areas are destroyed.

46 State one short-term economic benefit of deforestation. [1]

47 Explain how deforestation decreases biodiversity. [1]

48 Explain how wide-scale deforestation may contribute to global warming. [1]

Base your answer to questions 49 through 52 on the information below and on your knowledge of biology.

Zebra mussels have caused several major changes in the ecosystem in the Hudson River. Native to Eurasia, zebra mussels were accidentally imported to the Great Lakes in ships during the late 1980s and first appeared in the Hudson in 1990.

In regions of the Hudson north of West Point, zebra mussels have depleted the levels of dissolved oxygen to the point where many native organisms either die or move to other waters. In addition, large amounts of phytoplankton (small photosynthetic organisms) are consumed by the zebra mussels.

Before the introduction of zebra mussels, one typical food chain in this part of the Hudson was:

phytoplankton → freshwater clams → other consumers

49 As a result of the introduction of zebra mussels into the Hudson River, state one likely change in the population of each of two different species (other than the zebra mussels) found in the river. [1]

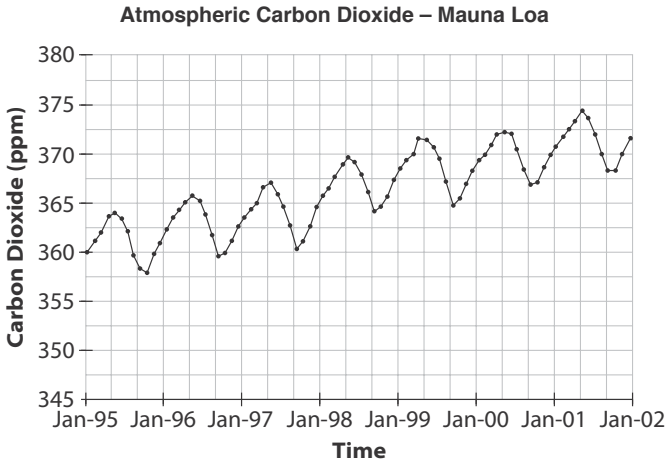
50 Identify one gas in this ecosystem and state how a change in its concentration due to the effects of zebra mussels would affect organisms other than the zebra mussels. [1]

51 State how the death of many of the native organisms could affect the rate of decay and how this would affect the amount of material being recycled. [1]

52 Explain why the size of the zebra mussel population would decrease after an initial increase. [1]

Base your answer to questions 53–56 on the information and graph below and on your knowledge of biology.

At an observatory in Mauna Loa, Hawaii, scientists have been measuring and collecting data related to changes in the atmosphere since the 1950s. The remote location of the observatory makes it ideal for studying atmospheric conditions that can cause climate change. One specific measurement taken is the amount of atmospheric carbon dioxide. Information for a 7-year period is shown in the graph below.



Source: www.mlo.noaa.gov

53–56 Analyze the data shown in the graph. In your answer, be sure to:

- state the overall relationship between time and carbon dioxide levels [1]
- state *one* possible cause for the overall change in the carbon dioxide levels shown in the graph [1]
- identify the biological process that might account for the decreases in carbon dioxide levels [1]
- identify *two* actions carried out by humans that could lower carbon dioxide levels [1]