

# MS Environmental Problems

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Doris Kraus, Ph.D. (DorisK)  
CK12 Editor

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## AUTHORS

Doris Kraus, Ph.D. (DorisK)  
CK12 Editor

## CONTRIBUTORS

Sarah Johnson, (SarahJ)

# CHAPTER 1 MS Environmental Problems

## CHAPTER OUTLINE

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- 1.1 Air Pollution
  - 1.2 Water Pollution and Waste
  - 1.3 Natural Resources
  - 1.4 Habitat Destruction and Extinction
  - 1.5 References
- 



The image shows smoke pouring into the sky from a factory. This smoke is polluting the air. But what does pollution mean? Is it polluting the air just above the factory? Does the pollution spread? What kind of effects does that kind of smoke have on the environment? What kind of effect does that pollution have on human health?

What about factories that pollute waterways, like rivers, lakes, and oceans? How does that kind of pollution affect the environment and human health? More importantly, what do you think you can do to decrease the amount of pollution in the air and waterways? Are there things you can in your daily life? Think about these questions as you read about the environmental consequences of human activities.

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# 1.1 Air Pollution

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## Lesson Objectives

- Discuss the types of outdoor pollution and what causes them.
- Describe the effects of outdoor pollution on the environment.
- Discuss where indoor air pollutants come from and what they are.
- Describe the health hazards of both indoor and outdoor pollutants.
- Discuss how you can protect yourself from air pollution.

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## Check your Understanding

- What is pollution?
- What is global warming?

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## Vocabulary

**acid rain** Precipitation or deposits with a low (acidic) pH.

**greenhouse gases** The cause of global warming by certain gases via the greenhouse effect.

**outdoor air pollution** Chemical, physical, or biological agents that modify the natural characteristics of the atmosphere, and cause unwanted changes to the environment and to human health.

**primary pollutants** Substances released directly into the atmosphere by processes such as fire or combustion of fossil fuels.

**secondary pollutants** Substances formed when primary pollutants interact with sunlight, air, or each other.

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## Pollution of Outdoor Air

Air is all around us. Air is essential for life. Sometimes, humans can pollute the air. For example, releasing smoke and dust from factories or cars can cause air pollution. This pollution affects entire ecosystems around the world. Pollution can also cause many human health problems and sometimes death.

You may be familiar with outdoor air pollution, but air pollution can also be found indoors. Air in its unpolluted state cannot be seen, smelled or tasted. Yet the gases in air are very important for life. For example:

- Nitrogen helps build proteins and nucleic acids.

- Oxygen helps to power life.
- Carbon dioxide provides the carbon to build bodies.
- Water supports most forms of life.

**Outdoor air pollution** is made of chemical particles. When smoke or other pollutants enter the air, the particles found in the pollution mix with the air. Air is polluted when it contains many large toxic particles. Outdoor air pollution changes the natural characteristics of the atmosphere.

**Primary pollutants** are added directly to the atmosphere. Fires are direct pollutants. Particles released from the fire directly enter the air and cause pollution (**Figure 1.1**). Burning of fossil fuels also directly pollutes the air (**Figure 1.2**).

**Secondary pollutants** are formed when primary pollutants interact with sunlight, air, or each other. They do not directly cause pollution. However, when they interact with other parts of the air, they do cause pollution. For example, ozone is created when some pollutants interact with sunlight. High levels of ozone in the atmosphere can cause problems for humans (see below). Both types can hurt the environment or human health.



**FIGURE 1.1**

Wildfires, either natural or human-caused, release particles into the air, one of the many causes of air pollution.

Most air pollutants can be traced to the burning of fossil fuels. Fossil fuels are burned during the following processes:

- In power plants to create electricity.
- To make machinery run.
- To power stoves and furnaces for heating.
- In transportation, such as cars, trains, and planes.
- In waste facilities.

Another word for "human-caused" is anthropogenic. Anthropogenic air pollution can be caused by agriculture, such as cattle ranching. The use of fertilizers and pesticides can also cause air pollution. Other sources of air pollution include:

**FIGURE 1.2**

A major source of air pollution is the burning of fossil fuels from factories, power plants, and motor vehicles.

- Production of plastics, refrigerants, and aerosols.
- Nuclear power and defense.
- Landfills.
- Mining.
- Biological warfare.

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## Environmental Effects of Outdoor Air Pollution

Many outdoor air pollutants may hurt the health of plants and animals, including humans. There are many specific problems caused by the burning of fossil fuels. These include acid rain and global warming.

### Acid Rain

Sulfur oxides are chemicals that are released from coal-fired power plants. Nitrogen oxides are released from motor vehicle exhaust. Sulfur oxides and nitrogen oxides can both cause **acid rain** (Figure 1.3). Acid rain has a very low pH. When the rain hits forests, freshwater habitats, or soils, it can kill insects and aquatic life.

### Global Warming

Global warming is an increase in the earth's temperature. It is thought to be caused mostly by the increase of **greenhouse gases** like carbon dioxide. Greenhouse gases can be released by factories that burn fossil fuels.

Over the past 20 years, burning fossil fuels has produced about three-quarters of the carbon dioxide from human activity. The rest of the carbon dioxide is caused by deforestation, or cutting down trees (Figure 1.4). Trees absorb carbon dioxide, so when trees are cut down, they cannot remove carbon dioxide from the air.

This increase in global temperature will cause the sea level to rise. It is also expected to cause an increase in extreme weather events. It may also change the amount of precipitation. Global warming may also cause food shortages and species extinction.

**FIGURE 1.3**

A forest in the Jizera Mountains of the Czech Republic shows effects caused by acid rain. What do you observe?

**FIGURE 1.4**

Deforestation, shown here as a result of burning for agriculture in southern Mexico, has produced significant increases in carbon dioxide emissions over the past 20 years.

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## Pollution of Indoor Air

Lack of indoor air movement causes air pollution to stay in places where people often spend a majority of their time. Some indoor pollutants include:

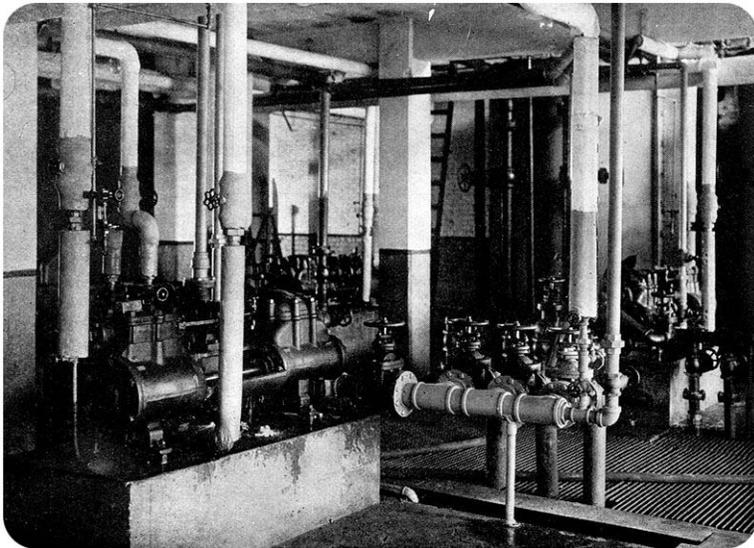
- Radon gas, released from the Earth in certain locations and then trapped inside buildings.
- Formaldehyde gas, emitted from building materials, such as carpeting and plywood.
- Volatile organic compounds (VOCs), given off by paint and solvents as they dry.

Other air pollutants include air fresheners, incense, and other scented items. Wood fires in stoves and fireplaces can produce significant amounts of smoke particles in the air. Use of pesticides and other chemical sprays indoors can

be another source of indoor pollution.

Other sources of air pollution include the following:

- Carbon monoxide (CO) is often released by faulty vents and chimneys or by the burning of charcoal indoors.
- Problems with plumbing can release of sewer gas and hydrogen sulfide.
- Dry cleaning fluids, such as tetrachloroethylene, can be released from clothing days after dry cleaning.
- The use of asbestos in factories and in homes in the past has left a very dangerous material in many buildings (**Figure 1.5**). Asbestos can cause cancer and other lung diseases.



**FIGURE 1.5**

The use of asbestos in industry and domestic environments in the past, as in the asbestos-covered pipes in the oil-refining plant pictured here, has left a potentially very dangerous material in many businesses.

Biological sources of air pollution are also found indoors. These are produced from:

- Pet dander.
- Dust from tiny skin flakes and decomposed hair.
- Dust mites.
- Mold from walls, ceilings, and other structures.
- Air conditioning systems can incubate certain bacteria and mold.
- Pollen, dust, and mold from houseplants, soil, and surrounding gardens.

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## Health Hazards of Air Pollution

The World Health Organization (WHO) reports that 2.4 million people die each year from causes directly related to air pollution. 1.5 million of these deaths are caused by indoor sources. Worldwide, there are more deaths linked to air pollution per year than to car accidents. Research by WHO also shows that the worst air quality is in countries with high poverty and population rates, such as Egypt, Sudan, Mongolia, and Indonesia.

Direct causes of air-pollution related deaths include:

- Asthma.
- Bronchitis.
- Emphysema.

- Lung and heart diseases.
- Respiratory allergies.

Certain respiratory conditions can be made worse in people who live closer to or in large cities. Some studies have shown that patients in urban areas suffer lower levels of lung function and more chronic bronchitis and emphysema. Air pollution can also cause an increase in cancer, eye problems, and other conditions. For example, use of certain agricultural herbicides and pesticides, such as DDT and PCBs, can all cause cancer.

### Effects of Smog on Health

If you live in a city, you have seen smog. It is a low-hanging, fog-like cloud that seems to never leave the city. Smog is caused by coal burning, and by ozone produced by motor vehicle exhaust. Smog can cause eye irritation and respiratory problems. Carbon monoxide from motor vehicle exhaust and from charcoal burning indoors can also cause poisoning and deaths.

### Protecting Yourself from Air Pollution

After reading the above sections, you may be confused as to where the air is healthier, outdoors or indoors. As for outdoor air pollution, if you hear in the news that the outdoor air quality is particularly bad, then it might make sense to wear a mask outdoors (**Figure 1.6** or to stay indoors.

Because you have more control over your indoor air quality than the outdoor air quality, there are some simple steps you can take indoors to make sure the air quality is less polluted:

- Make sure that vents and chimneys are working properly, and never burn charcoal indoors.
- Carbon monoxide detectors can be placed in the home.
- Keep your home as clean as possible from pet dander, dust, dust mites, and mold.
- Make sure air conditioning systems are working properly

Are there any other ways you can think of to protect yourself from air pollution?



**FIGURE 1.6**

Many people take to wearing masks in public to help maintain their health.

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## Lesson Summary

- Outdoor air pollution can change the natural characteristics of the atmosphere and cause unwanted changes to the environment and to human health.
- There are two kinds of pollutants: primary and secondary pollutants.
- There are many sources of human-caused air pollution, the most common being the burning of fossil fuels.
- Outdoor air pollutants cause many environmental effects, among them global warming, global dimming, and ozone depletion.
- Indoor air pollutants are either chemical or biological in nature.
- Both outdoor and indoor pollutants cause many health problems, ranging from respiratory and cardiac to cancer, eye problems, and poisoning.
- While it is not always possible to protect yourself from poor air quality outdoors, there are a number of measures you can take to protect yourself from poor indoor air quality.

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## Review Questions

### Recall

1. Define outdoor air pollution.
2. What is the difference between primary and secondary pollutants?
3. Give three examples of indoor air pollutants.

### Apply Concepts

4. Most air pollutants can be traced to the burning of fossil fuels. What are the sources of some of these pollutants?
5. Why does deforestation increase the effects of global warming?
6. Explain why one of the environmental effects of global dimming may result in less food at all trophic levels.
7. Name two environmental effects of ozone depletion.
8. Give an example of air pollutant and explain why it is bad for human health.

### Critical Thinking

9. Even though we have a hole in the ozone layer of the atmosphere, why is it ozone still considered a pollutant?

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## Further Reading / Supplemental Links

- Unabridged Dictionary, Second Edition, Random House, New York, 1998.
- <http://www.epa.gov/region5/students/air.htm>
- [http://www.epa.gov/acidrain/education/site\\_students/](http://www.epa.gov/acidrain/education/site_students/)
- <http://www.koshlandscience.org/exhibitgcc/index.jsp>

## Points to Consider

- One of the effects of outdoor air pollution is to cause global warming. How do the effects of global warming affect water pollution?
- How do outdoor air pollutants cause acid rain?

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## 1.2 Water Pollution and Waste

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### Lesson Objectives

- Describe water pollution sources.
- Explain how water pollution affects living organisms.
- Discuss how to prevent water pollution.
- Discuss ways you can save water

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### Check your Understanding

- What are water resources?
- What is the demand for water?
- What are the sources of fresh water?

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### Vocabulary

**algal bloom** Excessive growth of aquatic vegetation or phytoplankton as a result of eutrophication.

**ocean acidification** Process whereby the oceans' uptake of anthropogenic carbon dioxide from the atmosphere causes an ongoing decrease in ocean pH.

**waterborne diseases** Diseases caused by organisms transmitted via contaminated water.

**water pollution** The contamination of water bodies by substances, mostly anthropogenic, which cause a harmful effect on living organisms.

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### Sources of Water Pollution

While water may seem limitless and everywhere, it is actually a limited resource. A limited resource is one that we use faster than we can remake it. Unpolluted water is even harder to find (**Figure 1.7**).

**Water pollution** happens when contaminants enter water bodies. Contaminants are any substances that harm the health of the environment or humans. Most contaminants enter the water because of humans.

Natural events, like storms, algal blooms, volcanoes, and earthquakes can cause major changes in water quality. But human-caused contaminants have a much greater impact on the quality of the water supply. Water is considered polluted either when it does not support a human use, like clean drinking water, or a use for other animals and plants.

The main sources of water pollution can be grouped into two categories:

**FIGURE 1.7**

Water pollution can cause harmful effects to ecology and human health.

- Point source pollution results from the contaminants that enter a waterway or water body through a single site. Examples of this include untreated sewage, wastewater from a sewage treatment plant, and leaking underground tanks.
- Nonpoint source pollution is contamination that does not come from a single point source. Instead, it happens when there is a buildup of small amounts of contaminants that collect from a large area. Examples of this include fertilizer runoff from farms into groundwater or streams.

Specific contaminants causing water pollution include different types of chemicals and pathogens. A small amount of any chemical may not be toxic, but large amount of chemicals in a waterway can cause a lot of damage.

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## Effects of Water Pollution on Living Things

Water pollutants can have an effect on both the ecology of ecosystems and on human health.

### Pollution Problem: Eutrophication

Eutrophication is an increase in chemical nutrients, specifically compounds containing nitrogen or phosphorus, in an ecosystem. It occurs when run-off from lawn or farm fertilizers gets into natural waters, such as rivers or coastal waters.

Since there are such high levels of plant nutrients in the water, algae will grow, forming **algal blooms**. The algae grows so large and so fast that when it dies, it sucks the oxygen out of the water. Without oxygen, fish and shellfish cannot live (**Figure 1.8**).

As a result, humans cannot use the waterway for recreation, fishing or hunting. Drinking water can be affected if the toxic water enters the groundwater. Toxins created during the algal bloom can enter shellfish. If humans eat these shellfish, then they can get shellfish poisoning. This can cause neurological problems in humans.

**FIGURE 1.8**

Lake Valencia, Venezuela, showing green algal blooms. How did the algal bloom form? What will it do to the lake over time?

### Pollution Problem: Ocean Acidification

**Ocean acidification** occurs when carbon dioxide released by human factories into the atmosphere causes the oceans to become acidic. Burning fossil fuels leads to an increase in carbon dioxide into the atmosphere. This carbon dioxide is then absorbed by the oceans.

Ocean acidification can kill corals and shellfish. It may also cause marine organisms to reproduce less, which could harm other organisms in the food chain. As a result, there may be fewer marine organisms that humans consume.

### Pollution Problem: Aquatic Debris

Aquatic debris is trash that gets into fresh and saltwater waterways. It comes from shipping accidents, landfill erosion, or the dumping of trash.

Debris can be very dangerous to aquatic wildlife. Some may swallow plastic bags, while other organisms can be strangled by plastic six-pack rings. Wildlife can also get tangled in nets (**Figure 1.9**). This may decrease the amount of fish available for human consumption.

According to the World Health Organization (WHO), diarrheal disease is responsible for the deaths of 1.8 million people every year. It was estimated that 88% of cases of diarrheal disease are caused by unsafe water supply. Such **waterborne diseases** can be caused by protozoa, viruses, bacteria, and intestinal parasites. Protozoal infections can be caused by sewage, non-treated drinking water, animal manure, poor disinfection, and groundwater contamination.

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## Preventing Water Pollution

In the U.S., concern over water pollution resulted in the enactment of state anti-pollution laws in the latter half of the 1800s, and federal legislation in 1899. The laws prohibit the disposal of any waste into the nation's rivers, lakes,

**FIGURE 1.9**

Marine trash can harm different types of aquatic life. Pictured here is a marine turtle entangled in a net. How can you keep this from happening?

streams, and other bodies of water, unless a person first had a permit. In 1948, the Water Pollution Control Act was passed and gave power to the Surgeon General to reduce water pollution. Growing public awareness and concern for controlling water pollutants led to enactment of the Federal Water Pollution Control Act Amendments of 1972, also known as the Clean Water Act. The Clean Water Act set water quality standards. It also limits the pollution that can enter the waterways. Other countries are also actively preventing water pollution and purifying water (**Figure 1.10**).

**FIGURE 1.10**

A water purification system at Bret Lake, Switzerland. Contaminants are removed to make clean water.

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## Ways to Save Water

Saving water can help make sure we have clean water for future use. Preventing water pollution is one way of saving precious water resources. One way to make sure that water is kept clean and conserved is the use of wastewater reuse or cycling systems. This means that wastewater can be purified at a water treatment plant (**Figure 1.11**). When

wastewater is recycled, waterborne diseases caused by sewage and non-treated drinking water can be prevented.

There are various means of removing contaminants from water. Atmospheric water generation is one technology that can provide high quality drinking water. It involves extracting water from the air by cooling the air and turning it back into a liquid.



**FIGURE 1.11**

Sand processing mill near Provodin, Czech Republic. Water is used to wash mined sand, then is drained into tanks, filtered, and recycled.

Both developed and developing countries can increase protection of ecosystems, especially wetlands, in order to save clean water.

What are some ways you can save water in your own house or community in order to increase the resource of clean water, to be made available to everyone?

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## Lesson Summary

- There are two primary sources of water pollution, point sources and nonpoint sources.
- Specific contaminants causing water pollution include chemicals and pathogens.
- Water pollution can affect both ecology and human health.
- One effect of water pollution is eutrophication, which can harm aquatic ecosystems as well as on human life, including health.
- Water pollution also causes ocean acidification.
- Contaminated groundwater can lead to poisoned drinking water and various health problems, including cancer.
- A variety of water pollutants can cause waterborne diseases.
- Various legislation has regulated contaminants entering into water resources.
- Different ways of saving water can also have an impact on our clean water supply.

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## Review Questions

### Recall

1. When is water considered polluted?
2. What is point source pollution?
3. Name some sources of nonpoint source pollution.
4. Name some sources of pollutants that can cause waterborne diseases.

### Apply Concepts

5. Why are nonpoint sources of pollution so difficult to regulate?
6. Why might floating plastic debris be a problem for marine life?
7. What can you do to save clean water?

### Critical Thinking

8. Lakes often become polluted when sewage plants release phosphorous into the water. By what process would the release of phosphorus affect a lake's plant growth? How could this affect water quality and fish and shellfish populations?

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## Further Reading / Supplemental Links

- <http://www.epa.gov/region5/students/water.htm>
- <http://www.cdli.ca/CITE/water.htm>
- <http://www.epa.gov/region5/students/waste.htm>
- <http://en.wikipedia.org>

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## Points to Consider

- Even though water is a renewable resource, there is not always availability of clean water. Control of water pollution, such as removal of phosphorus or creating buffer zones near farms, helps to preserve this renewable resource for the future.
- Methods such as wastewater reuse, atmospheric water generation, reclaiming water, catchment management, and protection of aquatic systems can all contribute towards the dual goals of keeping water clean and also available for future generations.

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## 1.3 Natural Resources

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### Lesson Objectives

- Define natural resource.
- Describe renewable resources.
- Define nonrenewable resource.
- Discuss the use of fossil fuels as an energy source.
- List alternative uses to fossil fuels.
- Discuss how reducing, reusing, and recycling can help conserve resources.

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### Check your Understanding

- What are our natural resources?
- What is the difference between a renewable and nonrenewable resource?

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### Vocabulary

**erosion** Process by which the surface of the Earth is worn away by the action of winds, water, waves, glaciers, etc.

**hydropower** Use of power from falling water or other water movement to generate and distribute electricity; also known as hydroelectric power.

**natural resources** Naturally occurring substances necessary for the support of life.

**nonrenewable resource** A natural resource that exists in fixed amounts and can be consumed or used up faster than it can be made by nature.

**nuclear power** A nonrenewable resource, where nuclear fission is used to generate energy.

**recycling** The breaking down of an item into raw materials to make new items.

**reducing** Minimizing the use of resources.

**renewable resources** Resources that are replenished by natural processes at about the same rate at which they are used.

**solar power** The use of solar cells to convert sunlight into electricity.

**wind power** The conversion of wind energy into electricity via wind turbines.

## What are Natural Resources?

A **natural resource** is a naturally occurring substance that is necessary for the support of life. What resources do you use on a daily basis? You may think of air and water. What else is absolutely necessary to your survival? The food you eat. Can you survive with just air, water, and food? Are other resources, like the land you live on, the house you live in, the gasoline your parents put in the car and the tools you use at home or at school resources, too? Yes.

## Renewable Resources

A resource is *renewable* if it is remade by natural processes at the same rate that humans use it up. Sunlight and wind are **renewable resources** because they will not be used up (Figure 1.12 and Figure ??don't purge me). Tides are another example of a resource in unlimited supply.

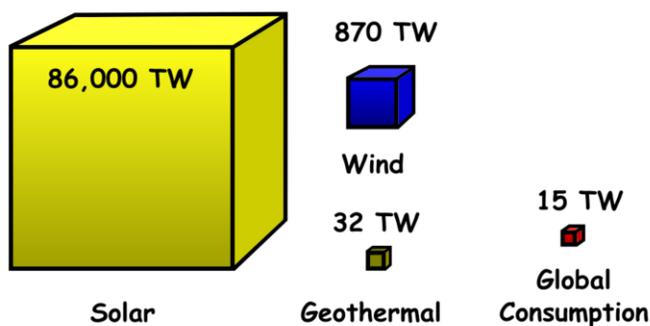


FIGURE 1.12

The figure shows you how much of each type of energy source is used worldwide. TW stands for terrawatt, which is a very large unit for measuring energy. Solar radiation and wind energy are considered renewable resources because both can be created just as fast as we use them.



FIGURE 1.13

Wind power, another renewable resource, shown here in a modern wind energy plant.

Based on what you learned in the last two lessons, would you say air and water are renewable resources? Your knowledge about air and water pollution would tell you that clean air and water are not always available.

Soils are often considered renewable, but **erosion** sometimes makes it nonrenewable. Erosion occurs when the nutrient-rich top levels of soil are removed because of wind or bad farming techniques (**Figure 1.14**).

Living things, like forests and fish, are considered renewable because they can reproduce to replace individuals lost to human consumption. But over-using these resources can lead to species extinction.

Also, metals and other minerals are sometimes considered renewable because they can be recycled.



**FIGURE 1.14**

Soil as a resource, showing a mixture of eroded rock, minerals, ions, water, air, roots, fungi, animals, and microorganisms, formed over thousands or possibly millions of years.

If something can be renewed, but at great cost economically or ecologically, should that resource still be considered renewable?

For example, energy resources from living things, such as ethanol, plant oils, and methane, are called renewable. But these can have harmful effects on the environment. For example, too much methane in the atmosphere can increase global warming.

*Sustainable* means that a resource is used in a way that meets the needs of the present without keeping future generations from meeting their needs. People can sustainably harvest wood, cork, and bamboo. Farmers can also grow crops sustainably by not planting the same crop in their soil year after year. Planting the same crop can suck all of the nutrients out of a soil.

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## Nonrenewable Resources

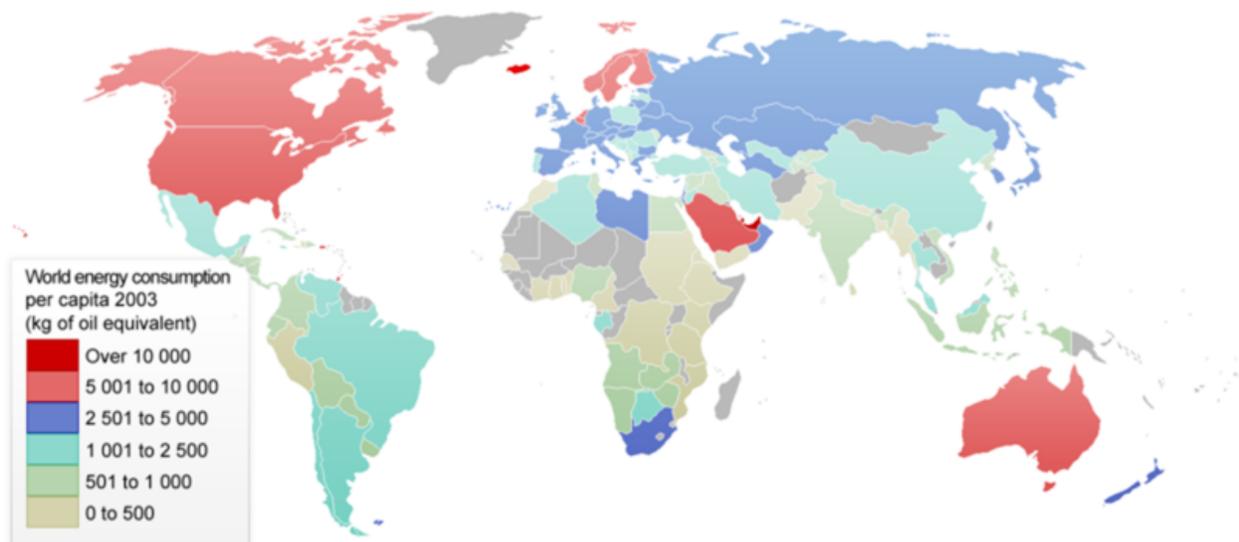
A **nonrenewable resource** is a natural resource that is consumed or used up faster than it can be made by nature. Two main types of nonrenewable resources are fossil fuels and nuclear power.

- Fossil fuels, such as petroleum, coal, and natural gas, formed from plant and animal remains over periods from 50 to 350 million years ago! It has been estimated that 20 metric tons of phytoplankton produce one liter of

gasoline. Humans have been consuming fossil fuels for less than 200 years, yet remaining reserves of oil can supply our needs for only 45 years. Gas can only supply us for another 72 years. Coal can only supply us for 252 years.

- **Nuclear power** is power developed from atoms in certain elements, such as uranium. Currently, there are limited uranium fuel supplies, which will last about 70 years at current rates of use. New technologies could make some uranium fuel reserves more useful.

Population growth, especially in developing countries, should make us think about how fast we are consuming resources. Developing nations will also increase demands on natural resources as they build more factories (**Figure 1.15**).



**FIGURE 1.15**

Per capita energy consumption (2003) shows the unequal distribution of wealth, technology, and energy use.

Improvements in technology, conservation of resources, and controls in population growth could all help to decrease the demand on natural resources.

## Fossil Fuels and Alternative Energy Sources

As you learned in the section on nonrenewable resources, fossil fuels are non-renewable resources. They take millions of years to form naturally, and cannot be replaced as fast as they are consumed.

It was estimated in 2005 that 86% of energy produced in the world came from burning fossil fuels. Wars have been fought over fossil fuels like oil. Producing and burning fossil fuels also harms the environment.

Alternative energy resources are being developed so we do not need to be dependent on fossil fuels anymore. Below are examples of sustainable alternative energy resources:

- **Solar power** uses solar cells to turn sunlight into electricity (**Figure 1.16**). The electricity can be used to power anything that uses normal coal-generated electricity.

**FIGURE 1.16**

An example of solar power, using solar cells to convert sunlight into electricity.

- **Wind power** uses windmills to transform wind energy into electricity. It is used for less than 1% of the world's energy needs. But wind energy is growing fast. Every year, 30% more wind energy is used to create electricity.
- **Hydropower** (**Figure 1.17**) uses the energy of moving water to turn turbines (similar to windmills) or water wheels, that create electricity. This form of energy produces no waste or pollution. It is a renewable resource.

**FIGURE 1.17**

Small hydropower plant, Buchholz, Switzerland.

Other alternative energy sources to the burning of fossil fuels include geothermal power, biomass biofuels, tidal power, nuclear energy, and fusion power. Let's examine these briefly to see how they compare with the sources of energy we've already discussed.

- Geothermal power uses the natural flow of heat from the earth's core to produce steam. This steam is used to turn turbines which create electricity.
- Biomass production involves using garbage or other renewable resources, like corn, to create electricity. When garbage decomposes, the methane produced is captured in pipes and burned to produce electricity. Wastes from agriculture could also be recycled. Biomass is generally renewable.
- Tides in the ocean can also turn a turbine to create electricity. This energy can then be stored until needed (**Figure 1.18**).
- Nuclear power plants use nuclear energy (fission) to create energy inside of a nuclear reactor. The nuclear reactor releases heat. The released heat, heats water to create steam, which spins a turbine. Again, the spinning turbine creates electricity (**Figure 1.19**).

**FIGURE 1.18**

Dam of the tidal power plant in the Rance River, Bretagne, France

What type of alternative energy source do you think is the most interesting? Which type should we use instead of fossil fuels?

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## Reduce, Reuse, and Recycle

You may have heard people say "Reduce, Reuse, Recycle." But what do each one of those words mean?

**Reducing** means decreasing the amount of waste we create. That could also mean cutting down on use of natural resources. Minimizing of waste may be difficult to achieve for individuals and households, but here are some starting points that you can include in your daily routine:

- When you go shopping for items, buy quantities you know you will use without waste.
- Turn lights off when not using them.
- Replace burned out bulbs with ones that are more energy-efficient.


**FIGURE 1.19**

Aerial photo of the Bruce Nuclear Generating Station near Kincardine, Ontario

- Reduce water use by turning off faucets when not using water.
- Use low-flow shower heads, which save on water and use less energy.
- Use low-flush and composting toilets.
- Put kitchen and garden waste into a compost pile.
- In the summer, change filters on your air conditioner and use as little air conditioning as possible.
- In winter, make sure your furnace is working properly and make sure there is enough insulation on windows and doors.
- Mend broken or worn items instead of buying new ones.
- Walk or bicycle instead of using an automobile, in order to save on fuel costs and to cut down on pollution.
- When buying a new vehicle, check into hybrid and semi-hybrid brands to cut down on gas mileage and pollution.

Let's now look at what we can reuse. Reusing includes using the same item again for the same function and also using an item again for a new function. Reuse can have both economic and environmental benefits. New packaging regulations are helping society to move towards these goals.

Some ways of reusing resources include:

- Use gray water. Water that has been used for laundry, for example, can be used to water the garden or flush toilets.
- At the town level, purified sewage water can be used for fountains, watering public parks or golf courses, fire fighting, and irrigating crops.
- Catching rain or runoff in rain barrels next to buildings.

What are some other ways to reuse resources?

Now we move on to **recycling**. Sometimes it may be difficult to understand the differences between reusing and recycling.

Recycling means taking a used item, breaking it down, and reusing the pieces. Even though recycling requires extra energy, it does often make use of items which are broken, worn out, or cannot be reused.

The things that are commonly recycled include:

- Concrete.

- Batteries.
- Biodegradable waste.
- Electronics.
- Iron and steel.
- Aluminum (**Figure 1.20**).
- Glass.
- Paper.
- Plastic.
- Textiles, such as clothing.
- Timber.
- Old ships.
- Tires.



**FIGURE 1.20**

These aluminum cans are packed together in a recycling plant to be reused.

Each type of recyclable requires a different recycling technique.

Here are some things you can do to recycle in your home, school, or community:

- If you have recycling in your community, make sure you separate out your plastics, glass, and paper if you need to.
- See if your school recycles. If not, you and some friends could start a recycling club, or organize efforts to better recycling goals

The amount that an individual wastes is small in proportion to all the waste produced by society. Yet all small contributions, when added up, make a difference. But that also means that laws need to be created to make sure people and companies reduce, reuse, and recycle. Individuals can vote for leaders who stand for sustainable and ecological practices. They can also tell their leaders to make wise use of natural resources

You can also influence companies. If you and your family only buy from companies and restaurants that support recycling or eco-friendly packaging, then other companies will also change to be more environmentally friendly.

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## Lesson Summary

- A natural resource is a naturally occurring substance that is necessary for the support of life.
- Resources are either renewable or nonrenewable.
- Examples of renewable resources include sunlight and wind tides.
- Nonrenewable resources include fossil fuels and nuclear power.
- Burning of fossil fuels causes harmful effects in the environment and can lead to war.
- There are a number of renewable energy sources which offer alternatives to the burning of fossil fuels. They include solar radiation, wind energy, and hydropower.
- Reducing waste, as well as reusing and recycling resources, can help save natural resources.
- There are many things you can do in your household and community to reduce, reuse, and recycle.
- Consumers can influence companies to become more environmentally friendly.
- Individuals can tell their leaders to make wise use of natural resources, and to vote for those leaders who stand for sound ecological practices.

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## Review Questions

### Recall

1. Define renewable resource.
2. Give two examples of nonrenewable resources.
3. Why is nuclear power considered a nonrenewable resource?

### Apply Concepts

4. Why must some natural renewable resources, such as geothermal power, fresh water, timber, and biomass be used carefully?
5. What human activities put increasing pressure on how fast we consume such resources?
6. What are the main disadvantages to the burning of fossil fuels as an energy source?
7. What two advantages do solar power, wind power, and hydropower all have in common?

### Critical Thinking

8. Pick one renewable or alternative energy resource. Explain to your mayor why you think it would be good for your community to invest in this natural resource.

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## Further Reading / Supplemental Links

- <http://dnr.state.il.us/lands/education/index.htm>
- <http://www.nrcs.usda.gov/feature/education/squirm/skworm.html>
- <http://fossil.energy.gov/education/energylessons/index.html>
- [http://www1.eere.energy.gov/education/report\\_resources.html](http://www1.eere.energy.gov/education/report_resources.html)

- <http://www.epa.gov/region5/students/waste.htm>
- [http://en.wikipedia.org/wiki/Water\\_conservation](http://en.wikipedia.org/wiki/Water_conservation)

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## Points to Consider

- Why do you think it is important to protect natural habitats?
- Discuss how the protection of natural resources may be important for biodiversity.

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## 1.4 Habitat Destruction and Extinction

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### Lesson Objectives

- Discuss what causes destruction of habitats.
- Explain why habitat destruction threatens species.
- Describe causes of extinction other than habitat destruction.
- Explain why biodiversity is important.
- Explain why habitat protection is important, including for maintaining biodiversity.

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### Check your Understanding

- What is a habitat?
- What is habitat destruction?
- What is the effect of habitat destruction?
- What is biodiversity?

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### Vocabulary

**biodiversity** The number of different species or organisms in an ecological unit (i.e. biome or ecosystem).

**desertification** A process leading to production of a desert of formerly productive land.

**extinction** The cessation of existence of a species or group of taxa.

**invasive species** Exotic species, introduced into habitats, which then eliminate or expel the native species.

**slash-and-burn agriculture** A method of agriculture in the tropics in which the forest vegetation is cut down and burned, then crops are grown for a few years, and then the forest is allowed to grow back.

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### The Importance of Biodiversity

Some of the importance of biodiversity is shown in the following three figures (**Figure 1.21**, **Figure 1.22**, and **Figure 1.23**). In this lesson you will read about habitat destruction and the impact of this destruction on biodiversity. **Biodiversity** is a measurement of the amount of variation of the species in a given area.



FIGURE 1.21

A sampling of some of the wide diversity of animal species on earth.



FIGURE 1.22

Coral reefs are one of the biomes with the highest biodiversity on earth.

**FIGURE 1.23**

This tropical rain forest shows another biome having one of the greatest biodiversities on earth.

## Causes of Habitat Destruction

From a human point of view, a habitat is the environment where you live, go to school, go to have fun, and regularly visit. A habitat is the natural home or environment of an organism. Humans often cause habitat destruction for other organisms. Humans cause habitat destruction by land clearing (**Figure 1.24**) and by the introduction of non-native species of plants and animals. Habitat destruction can cause the extinction of species (**Figure 1.25**). **Extinction** is the complete disappearance of a species. Once a species is extinct, it can never recover.

**FIGURE 1.24**

Slash-and-burn agriculture, shown here in southern Mexico, clears land for agriculture.

**FIGURE 1.25**

An exotic species, the brown tree snake, hitchhiked on an aircraft to the Pacific Islands, causing the extinctions of many bird and mammal species which had evolved in the absence of predators.

### Land Loss

Clearing habitats of plants for agriculture and development is a major cause of destruction. Within the past 100 years, the amount of total land used for agriculture has almost doubled. Land for the grazing of cattle has more than doubled.

Agriculture alone has cost the United States half of its wetlands (**Figure 1.26**) and almost all of its tallgrass prairies (**Figure 1.27**). Native prairie ecosystems, with their thick fertile soils, deep-rooted grasses, diversity of colorful flowers, burrowing prairie dogs, and herds of bison and other animals, have virtually disappeared (**Figure 1.28**).

**FIGURE 1.26**

Wetlands such as this one in Cape May, New Jersey, filter water and protect coastal lands from storms and floods.

### Slash-and-Burn Agriculture

Other habitats that are being rapidly destroyed are forests, especially tropical rainforests. The rainforest is one of the two major ecosystems with the greatest biodiversity on earth. The largest cause of deforestation today is **slash-and-burn agriculture** (**Figure 1.24**). This means that when people want to turn a forest into a farm, they cut down

**FIGURE 1.27**

Big bluestem grasses as tall as a human were one of the species of the tallgrass prairie, largely destroyed by agricultural use.

**FIGURE 1.28**

Herds of bison also made up part of the tallgrass prairie community.

all of the trees and then burn them. This technique is used by over 200 million people in tropical forests throughout the world.

These people use the soil very quickly, so nutrients are lost. This often results in people abandoning the forest within a few years. The abandonment can cause erosion and lead to desertification. **Desertification** turns forest into a desert, where it is difficult for plants to grow. Half of the earth's mature tropical forests are gone. At current rates of deforestation, all tropical forests will be gone by 2090.

### Non-native Species

One of the main causes of extinction is introduction of exotic species into an environment. These exotic and new species can also be called **invasive species**. Invasive species out-compete the native species for resources. Sometimes native species are so successful at living in a certain habitat that the native species go extinct.

Recently, cargo ships have transported zebra mussels, spiny waterfleas, and ruffe (a freshwater fish) into the Great

Lakes (**Figure 1.29**). These invasive species are better at hunting for food. They have caused some of the native species to go extinct.

Invasive species can disrupt food chains, carry disease, prey on native species directly, and out-compete native species for limited resources, like food. All of these effects can lead to extinction of the native species.



**FIGURE 1.29**

These zebra mussels, an invasive species, live on most man-made and natural surfaces. Here they have infested the walls of the Arthur V. Ormond Lock on the Arkansas River. They have caused significant damage to American waterways, locks, and power plants.

Other causes of habitat destruction include poor fire management, overfishing, mining (**Figure 1.30**), pollution, and storm damage.



**FIGURE 1.30**

Strip coal mining, pictured here, has destroyed the entire ecosystem.

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## Examples of Habitat Destruction

### Wetlands

A habitat that is quickly being destroyed is the wetland. By the 1980s, over 80% of all wetlands in seven states of the U.S. were destroyed. In Europe, many wetland species have gone extinct. For example, many bogs in Scotland have been lost because of human development. Over half of the Portlethen moss in Aberdeenshire, for example, has been lost. A number of species, such as the great crested newt, have gone extinct.

Another example of species loss due to habitat destruction happened on Madagascar's central highland plateau. From 1970 to 2000, slash-and-burn agriculture destroyed about 10% of the country's total native plants. The area turned into a wasteland. Soil from erosion entered the waterways. Much of the river ecosystems of several large rivers were also destroyed. Several fish species are almost extinct. Also, some coral reef formations in the Indian Ocean are completely lost.

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## Other Causes of Extinction

### Global Warming

Another major cause of extinction is global climate change. As we have already seen earlier in this chapter, our increasing need for coal and oil is changing the earth's climate. Any change in the climate can destroy the habitat of a species. For example, if the seas increase in temperature, it may be too warm for certain types of fish to reproduce.

### Overpopulation

Human populations are on the rise. The highest population growth rates are often in developing tropical countries. These countries are also where biodiversity is highest. Development by humans can cause habitats to be destroyed. This destruction can force species to go extinct, or move somewhere else.

### Pollution

Pollution adds chemicals, noise, heat, or even light to an environment. This can have many different harmful effects on all kinds of organisms. For example, the pesticide DDT destroyed the habitat of the peregrine falcon. The pesticide collected in organisms low on the food chain. When organisms high on the food chain started to consume the organisms that contained the chemical, they started to die. This caused the disappearance of the peregrine falcon from this area. DDT was then banned in the U.S.

Water pollution threatens vital freshwater and marine resources throughout the world (**Figure 1.31**). Specifically, industrial and agricultural chemicals, waste, acid rain, and global warming threaten water. As water is essential for all ecosystems, water pollution can result in extinction.

Finally, soil contamination can also result in extinction. Soil contamination can come from toxic industrial and municipal wastes (**Figure 1.32**), salts from irrigation, and pesticides from agriculture. These all degrade the soil as well. As soil is the foundation of terrestrial ecosystems and their biodiversity, this can result in extinction.



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**FIGURE 1.31**

An oiled bird from an oil spill in San Francisco Bay. About 58,000 gallons of oil spilled from a South Korea-bound container ship when it struck a tower supporting the San Francisco-Oakland Bay Bridge in dense fog in November, 2007.

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**FIGURE 1.32**

Soil contamination caused by underground storage tanks containing tar.

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## Importance of Biodiversity

Does it matter if we are losing thousands of species each year? The answer is yes. It matters even if we consider only direct benefits to humans. But there are many benefits to ecosystems.

## Economic Importance

Economically, there are many direct benefits of biodiversity. In our food supply, when we grow one type of crop on large areas of farmland, it is called a monoculture. Unfortunately, when a certain type of crop is grown year after year, it becomes more likely to develop disease. Agriculture benefits from biodiversity. In 1970, a disease almost wiped out 80% of corn grown in the U.S. (**Figure 1.33**). This would not have happened if there was a diversity of corn being grown. Certain species of corn would have contracted the disease, while others would not have contracted it.



**FIGURE 1.33**

In order to increase the genetic diversity of corn, these unusually colored and shaped Latin American maize are bred with domestic corn lines. Such hybrids may have increased resistance to local diseases.

As many as 40,000 species of fungi, plants, and animals provide us with many varied types of clothing, shelter, and other products. These include poisons, timber, fibers, fragrances, papers, silks, dyes, adhesives, rubber, resins, skins, furs, and more. According to one survey, 57% of the most important prescription drugs come from nature. Specifically, they come from bacteria, fungi, plants, and animals. (**Figure 1.34**). But only a small amount of species with the ability to give us medicines have been explored. The loss of any species may mean the loss of new medicines.

Bionics, also known as biomimetics or biomimicry, uses organisms to inspire technology or engineering projects. For example, rattlesnake heat-sensing pits helped inspire the development of infrared sensors. Zimbabwe's Eastgate Centre (**Figure 1.35**) was inspired by the air-conditioning efficiency of a termite mound (**Figure 1.36**).

## Ecological Importance

At an ecological level, biodiversity has many benefits. Biodiversity makes ecosystems more stable. Biodiversity helps keep the nutrients in the soil. For example, a diversity of organisms in the soil allows nitrogen fixation and nutrient recycling to happen. Biodiversity allows plants to be pollinated by different types of insects. Also, different species of fungi are necessary to recycle wastes from dead plants and animals. These are just a few of the many examples of how biodiversity is important for ecosystems.

Biodiversity is critically important for us and for the earth. What can you do to help protect habitats?

**FIGURE 1.34**

Aspirin comes from the bark of the white willow, pictured here.

**FIGURE 1.35**

Design of the Eastgate Centre, in Zimbabwe, which requires just 10% of the energy needed for a conventional building of the same size, was inspired by a biological design.

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## Protecting Habitats

There are lots of things we can do to protect biodiversity:

- Reduce, reuse, and recycle all resources.
- Do not introduce invasive species.
- Practice sustainable development of land.
- Learn more about biodiversity and its importance.
- Vote for lawmakers who make sure biodiversity is protected.

**FIGURE 1.36**

The air-conditioning efficiency of this termite mound was the inspiration for the Eastgate Centre.

You can also support areas that protect habitats, like national parks, nature reserves, state parks, and even community and town parks.

Think about sustainable management even at the level of your own backyard. What does your household do with organic waste? Do you have a compost pile, or would you or your family consider starting one? What kinds of trees and shrubs are planted in your yard? Are they native or invasive species? Are they drought-tolerant?

Research some of the vegetation you can plant that will attract native bird, mammal, and other species. Put out bird feeders, especially in the winter in areas where birds may have trouble finding food.

Remember that in addition to all the actions you can take, learning about biodiversity and ecology is an important part of valuing and protecting the diversity of life. Pass on what you learn to others.

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## Lesson Summary

- There are a number of causes of habitat destruction, including clearing of land, introduction of invasive species, overfishing, mining, pollution, and storm damage.
- Some habitats affected by destruction include tropical rainforests, wetlands, and coral reefs.
- Biodiversity is important because it directly benefits humans and ecosystems.
- Because of the importance of biodiversity and habitats, it is important that we do what we can as citizens to protect habitats.

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## Review Questions

### Recall

1. What are two major causes of habitat destruction?
2. What is the largest cause of deforestation today?

### Apply Concepts

3. How can habitat destruction through pollution kill a species over a long period of time?
4. Why do introduced exotic species have unexpected and negative effects in the new ecosystems?
5. Why is it important to grow different species of the same type of plant?
6. What are some of the things you can do to have a sustainably managed backyard?

### Critical Thinking

7. Explain how biological magnification played a role in the disappearance of the peregrine falcon from the eastern U.S.
8. Pick an environment near where you live that is a natural ecosystem (like a wetland or other area). Explain to a law-maker why it is important to maintain biodiversity in that particular environment.

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## Further Reading / Supplemental Links

- <http://www.fws.gov/endangered/kids/index.html>
- <http://www.blm.gov/education/LearningLandscapes/students.html>
- <http://www.epa.gov/owow/oceans/kids.html>
- <http://www.biodiversityproject.org/biodiversity.htm>
- <http://ology.amnh.org/biodiversity>
- <http://www.biodiversity911.org>
- <http://en.wikipedia.org>

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## Points to Consider

- Global warming and climate change are frequently in the news these days, with reports of glaciers melting, and possible effects on species, such as the polar bear. Keep aware of these news trends and learn what you can about what species are becoming threatened.
- Our purchasing decisions may affect biodiversity: be more aware of the natural resources used to make and transport any product you buy; Buy recycled products whenever possible; when you buy fish for food, check to be sure that commercial species are not from overharvested areas.

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## 1.5 References

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