25. Environmental Problems

Air Pollution

- Pollution of Outdoor Air
- Environmental Effects of Outdoor Air Pollution
- Pollution of Indoor Air
- Health Hazards of Air Pollution
- Protecting Yourself from Air Pollution

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.

Check your Understanding

- Describe the five layers of the earth's atmosphere.

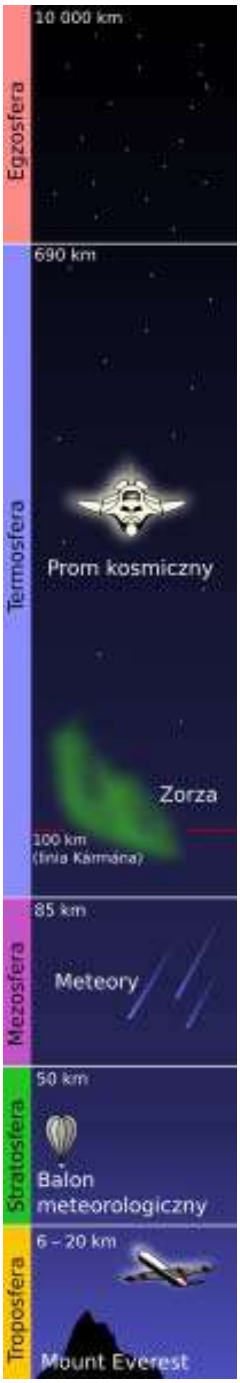

Figure 1: Layers of the atmosphere.

(*Source:* http://commons.wikimedia.org/wiki/Image:Atmosphere_layers-pl.svg, *License:* Public Domain)

1. Exosphere: from 300-600 mi up to 6,000 mi

2. Thermosphere: from 265,000 – 285,000 ft to 400+ mi

3. Mesosphere: from about 160,000 ft to the range of 265,000 – 285,000 ft

4. Stratosphere: from 23,000 – 60,000 ft range to about 160,000 ft; contains most of the ozone layer (with relatively high [a few parts per million] concentrations of ozone – the ozone layer is mainly located from approximately 50,000 to 115,000 ft above Earth's surface)

5. Troposphere: from the Earth's surface to between 23,000 ft at the poles and 60,000 ft at the equator

- Describe the chemical composition of the atmosphere.
- Explain the significance of the atmosphere.

Introduction

Air is all around us and is everywhere and its mix of gases is essential for life. Despite the atmosphere's vastness, human activities, like the emission of chemical substances, particulate matter (smoke and dust), and even biological materials, cause air pollution. This pollution affects entire ecosystems, worldwide. Pollution is also a big problem indoors. Pollution, both the outdoor and indoor varieties, cause many health problems as well as deaths. In spite of all the dangers to human health from pollutants, there are ways for you to protect yourself.

Pollution of Outdoor Air

Air is so easy to take for granted. In its unpolluted state, it cannot be seen, smelled, tasted, felt, or heard, except when it blows or during cloud formation. Yet its gases are very important for life: nitrogen helps build proteins and nucleic acids, oxygen helps to power life, carbon dioxide provides the carbon to build bodies, and water has many unique properties which most forms of life depend on.

Outdoor air pollution consists of either chemical, physical (e.g. particulate matter), or biological agents that modify the natural characteristics of the atmosphere and cause unwanted changes to the environment and to human health. **Primary pollutants** are added directly to the atmosphere by such processes as fires or combustion of fossil fuels, such as oil, coal, or natural gas. **Secondary pollutants** are formed when primary pollutants interact with sunlight, air, or each other. Both types are equally damaging.

Figure 2: Wildfires, either natural- or human-caused, release particulate matter into the air, one of the many causes of air pollution.

(*Source:* http://commons.wikimedia.org/wiki/Image:Wildfiretopanga.jpg, *License:* Public Domain)

Figure 3: A major source of air pollution is the burning of fossil fuels from factories, power plants, and motor vehicles. Photo was taken prior to installation of emission controls equipment for removal of sulfur dioxide and particulate matter.

(*Source:* http://commons.wikimedia.org/wiki/Image:Air_.pollution_1.jpg, *License:* Public Domain, US Federal Government)

Figure 4: The majority of air pollutants can be found in the burning of fossil fuels for heat, electricity, industry, waste disposal, and transportation, the latter seen here on a busy highway.

(*Source:* http://commons.wikimedia.org/wiki/Image:Air-pollution.jpg, *License:* GNU-FDL)

Most air pollutants can be traced to the burning of fossil fuels. These include the burning of fuels in power plants to generate electricity, in factories to make machinery run, in stoves and furnaces for heating, in various modes of transportation, and in waste facilities to burn waste. Even before the use of fossil fuels since the Industrial Revolution, wood was burned for heat and cooking in fireplaces and campfires, and vegetation was burned for agriculture and land management.

In addition to the burning of fossil fuels, other sources of human-caused (**anthropogenic**) air pollution are agriculture, such as cattle ranching, fertilizers, herbicides and pesticides, and erosion; industry, such as production of solvents, plastics, refrigerants, and aerosols; nuclear power and defense; landfills; mining;

and biological warfare.

Environmental Effects of Outdoor Air Pollution

Many outdoor air pollutants may impair the health of plants and animals (including humans). There are many specific problems caused by the burning of fossil fuels. For example, sulfur oxides from coal-fired power plants and nitrogen oxides from motor vehicle exhaust cause **acid rain** (precipitation or deposits with a low pH). This has adverse effects on forests, freshwater habitats, and soils, killing insects and aquatic life.

Figure 5: A forest in the Jizera Mountains of the Czech Republic shows effects attributed to acid rain. At higher altitudes, effects of acid rain on soils combines with increased precipitation and fog to directly affect foliage.

(*Source:* http://commons.wikimedia.org/wiki/Image:Acid_rain_woods1.jpg, *License:* Public Domain)

Global warming (an increase in the earth's temperature) is thought to be caused mostly by the increase of **greenhouse gases** (water vapor, carbon dioxide, methane, ozone, chlorofluorocarbons (CFCs), nitrous oxide, hydrofluorocarbons, and perfluorocarbons) via the **greenhouse effect** (the atmosphere's trapping of heat energy radiated from the Earth's surface).

Water vapor causes about 36-70% of the greenhouse effect and carbon dioxide causes 9-26%. Fossil fuel burning has produced approximately three-quarters of the carbon dioxide from human activity over the past 20 years, while most of the rest is due to land-use change, particularly deforestation. Methane causes 4-9% of the greenhouse effect and ozone causes 3-7%. Some other naturally occurring gases contribute very little to the greenhouse effect; one of these, nitrous oxide, is increasing in concentration due to an increase in such human activities as agriculture.

Figure 6: Deforestation, shown here as a result of burning for agriculture in southern Mexico, has produced significant carbon dioxide production over the past 20 years.

(*Source:* http://commons.wikimedia.org/wiki/Image:Lacanja_burn.jpg, *License:* Public Domain)

The effect of global warming is to increase the average temperature of the Earth's near-surface air and oceans. This increase in global temperature will cause the sea level to rise and is expected to cause an increase in intensity of extreme weather events and to change the amount and pattern of precipitation. Other effects of global warming include changes in agricultural yields, trade routes, glacier retreat, and species extinctions.

Other environmental problems caused by human-caused air pollution include **global dimming** (a reduction in the amount of radiation reaching the Earth's surface) and **ozone depletion** (the latter being two related declines in stratospheric ozone). Particulate matter from the burning of wood and coal and **aerosols** (airborne solid particles or liquid droplets) cause global dimming, by absorbing solar energy and reflecting sunlight back into space. Environmental effects of global dimming include less photosynthesis, resulting in less food for all trophic levels; less energy to drive evaporation and the hydrologic cycle; and cooler ocean temperatures, which may lead to changes in rainfall and drought.

Ozone is both a benefit and detriment. As a component of the upper atmosphere, it has shielded all life from as much as 97-99% of the lethal solar ultraviolet (UV) radiation. However, as a ground-level product of the interaction between pollutants and sunlight, ozone itself is considered a pollutant which is toxic to animals' respiratory systems.

Ozone depletion consists of both losses in the total amount of ozone in the Earth's stratosphere – about 4% per year from 1980 to 2001, and the much larger loss, the **ozone hole,** a seasonal decline over Antarctica. A secondary effect of ozone depletion is a decline in stratospheric temperatures. The pollutants that are responsible for ozone depletion are CFCs, from the use of aerosol sprays, refrigerants (Freon), cleaning solvents, and fire extinguishers.

Ozone depletion and the resulting increase in levels of UV radiation reaching Earth could result in the reduced abundance of UV-sensitive nitrogen-fixing bacteria, which cause a disruption of nitrogen cycles, and a loss of plankton, causing a disruption of ocean food chains.

Pollution of Indoor Air

Lack of indoor ventilation and circulation concentrates air pollution in places where people often spend a majority of their time, and allows them to accumulate more than they would otherwise occur in nature. Some of these 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) are given off by paint and solvents as they dry; and lead paint, which can degenerate into dust.

Other air pollutants are caused by the use of air fresheners, incense, and other scented items. Wood fires in stoves and fireplaces can produce significant amounts of smoke particulates into the air. Use of pesticides and other chemical sprays indoors, without proper ventilation, can be another source of indoor pollution.

Carbon monoxide (CO) is often released by faulty vents and chimneys, poorly adjusted pilot lights, or by the burning of charcoal indoors. Flaws (non-functioning built-in traps) in domestic plumbing can result in emission of sewer gas and hydrogen sulfide. Dry cleaning fluids, such as tetrachloroethylene, can be emitted from clothing, days after dry cleaning. The extensive use of asbestos in industrial and domestic environments in the past has left a potentially very dangerous material in many localities.

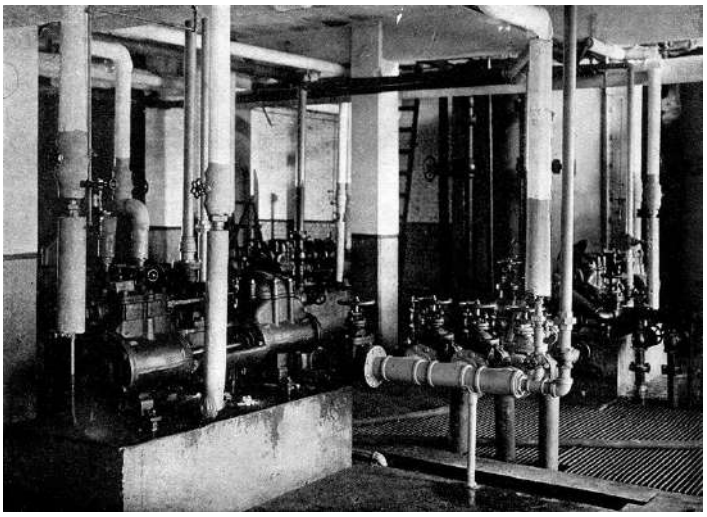

Figure 7: The extensive use of asbestos in industrial (as pictured here, asbestos-covered pipes in an oil-refining plant) and domestic environments in the past has left a potentially very dangerous material in many localities.

(*Source:* http://commons.wikimedia.org/wiki/Image:Asbestos-Covered_Pipes_CNE-v1-p58-E.jpg, *License:* Public Domain)

Biological sources of air pollution, such as gases and airborne particulates, are also found indoors. These are produced from pet dander; dust from minute skin flakes and decomposed hair; dust mites (which produce enzymes and micrometer-sized fecal droppings) from bedding, carpeting, and furniture; methane from the inhabitants; mold (which generates mycotoxins and spores) from walls, ceilings, and other structures; air conditioning systems, can incubate certain bacteria and mold; and pollen, dust, and mold from houseplants, soil, and surrounding gardens.

Health Hazards of Air Pollution

The World Health Organization (WHO) states that 2.4 million people die each year from causes directly related to air pollution, and 1.5 million of these deaths caused by indoor sources. One study has shown a strong correlation between pneumonia-related deaths and air pollution caused by motor vehicles. Worldwide, there are more deaths linked to air pollution per year than to car accidents. Research by WHO also shows that the greatest concentration of particulate matter particles exists in countries with high poverty and population rates, such as Egypt, Sudan, Mongolia, and Indonesia.

Direct causes of air-pollution related deaths include aggravated asthma, bronchitis, emphysema, lung and heart diseases, and respiratory allergies. The U.S. Environmental Protection Agency (EPA) estimates that a set of proposed changes in technology of diesel engines could result each year in the U.S. in 12,000 fewer

mortalities, 15,000 fewer heart attacks, 6,000 fewer visits to the emergency room by children with asthma, and 8,900 fewer respiratory-related admissions to the hospital.

Health effects caused by air pollution may range from subtle physiological and biochemical changes to difficulties in breathing, wheezing, coughing, and aggravation of existing cardiac and respiratory conditions. These conditions can result in increased use of medications, visits to the doctor or emergency room, more admissions to the hospital, and premature deaths. Individual reactions to air pollution depends on the type of pollutant, the degree of exposure, and the individual's medical condition.

Certain respiratory conditions can be made worse in people who live closer or in large metropolitan areas. In one study, it was found that such patients had higher levels of pollutants found in their system because of more emissions in the larger cities. In patients with the disease of cystic fibrosis, patients already born with decreased lung function, had worse lung function as a result of such pollutants as smoke emissions from automobiles, tobacco smoke, and improper use of indoor heating devices. Some studies have shown that patients in urban areas suffer lower levels of lung function and more self diagnosis of chronic bronchitis and emphysema.

Because children are outdoors more they are more susceptible to the dangers of air pollution. Children living within cities with high exposure to air pollutants are at risk to develop asthma, pneumonia and other lower respiratory infections.

In addition to respiratory and heart-related ailments, 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 (an organic pesticide) and PCBs (poly-chlorinated biphenyls), use of some industrial solvents and plastics, radioactive waste, use of some indoor materials like asbestos, and ozone depletion can all cause cancer.

Smog, caused by coal burning, and ground-level ozone produced by motor vehicle exhaust can cause eye irritation, as well as respiratory problems, and ozone depletion can cause an increased incidence of cataracts. Carbon monoxide from motor vehicle exhaust and from faulty vents and chimneys and charcoal burning indoors can cause poisoning and fatalities. Mercury released from coal-fired power plants and from medical waste can cause neurotoxicity (poisoning to nerve tissue).

Protecting Yourself from Air Pollution

After reading the above sections, you may be confused as to where the air is healthier, outdoors or indoors? While it is not always possible to know what exact steps you should take under any situation, common sense often plays a role. For example, if you hear in the news that the outdoor air quality is particularly bad, then it might make sense to either wear masks outdoors or to stay indoors as much as possible at such times, especially if you already have such respiratory conditions as asthma, for example. 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.

Perhaps you could review the section, "Pollution of Indoor Air" above, and come up with some ideas for how you could reduce indoor air pollution. For example, make sure your house is well ventilated and there is circulation of air. Try to avoid use of toxic substances in the home; always read labels to see what warnings about toxic ingredients are listed. If you are not sure about a particular product, use either outdoors or in a well-ventilated room and avoid direct inhalation. Use of medical supply masks is also helpful to protect yourself further.

Make sure that vents, chimneys, and vents are working properly and never burn charcoal indoors. Carbon monoxide detectors can be placed in the home, if carbon monoxide emission is of concern. In addition, keeping your home as clean as possible from pet dander, dust, dist mites, and mold, and making sure air conditioning systems are working properly can minimize effects on asthma and other respiratory problems.

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

Lesson Summary

- Outdoor air pollution consists of either chemical, physical, or biological agents that modify 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.

Review Questions

1. Define outdoor air pollution. **(Beginning)**

2. Most air pollutants can be traced to the burning of fossil fuels. What were the sources of such pollutants before the Industrial Revolution? **(Intermediate)**

3. Why does deforestation contribute to an increase in global warming? **(Challenging)**

4. Explain why one of the environmental effects of global dimming may result in less food at all trophic levels. **(Intermediate)**

5. Name two environmental effects of ozone depletion. **(Beginning)**

6. There is no direct evidence linking ozone depletion to a higher incidence of skin cancer in human beings. Give an explanation for this. **(Challenging)**

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.koshlandscience.org/exhibitgcc/index.jsp

en.wikipedia.org/wiki

Vocabulary

acid rain	Precipitation or deposits with a low (acidic) pH.
aerosols	Airborne solid particles or liquid droplets.
air	The mixture of gases present in the atmosphere.
anthropogenic	Human-based causes.

atmosphere	A layer of gases that surrounds the planet; composed of five layers.
global dimming	A reduction in the amount of radiation reaching the Earth's surface.
global warming	The recent increase in the Earth's temperature.
greenhouse effect	The atmosphere's trapping of heat energy radiated from the Earth's surface.
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.
ozone depletion	Reduction in the stratospheric concentration of ozone.
ozone hole	A seasonal decline of ozone over Antarctica.
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.

Review Answers

1. Outdoor air pollution consists of either chemical, physical, or biological agents that modify the natural characteristics of the atmosphere and cause unwanted changes to the environment and to human health.

2. The burning of wood for heat and cooking in fireplaces and campfires, and the burning of vegetation for agriculture and land management.

3. Deforestation reduces levels of carbon dioxide uptake by trees. Therefore, there is an increase in carbon dioxide levels in the atmosphere (a significant contributor to the greenhouse effect), which leads to the absorption of heat, normally radiated out into space, by the carbon dioxide, as well as by any other greenhouse gases. This, in turn, results in an increase in global warming.

4. Because global dimming has the effect of absorbing solar energy and reflecting sunlight back into space, one result of this is to decrease photosynthesis, thereby affecting food production at all trophic levels.

5. Reduced abundance of UV-sensitive nitrogen-fixing bacteria and a loss of plankton.

6. It is partly due to the fact that the UV-A wavelength (UVA) of UV radiation, which has been implicated in some forms of skin cancer, is not absorbed by ozone.

Points to Consider

- One of the effects of outdoor air pollution is to cause global warming. Global warming, in turn, has an effect on both land and sea. Think about how the effects of global warming on the amount and pattern of precipitation will have an effect on water pollution.
- Environmental effects of global dimming include less energy to drive evaporation and the hydrologic cycle, and cooler ocean temperatures, which may lead to changes in rainfall and drought. Will such changes affect water pollution?
- Some outdoor air pollutants have a direct effect on aquatic habitats. For example, acid rain can adversely affect freshwater habitats.

Water Pollution and Waste

- Sources of Water Pollution
- Effects of Water Pollution on Living Things

- Preventing Water Pollution
- Ways to Save Water

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.

Check your Understanding

Water pollution obviously has to do with water.

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

Answers

- Surface water is water found in rivers, lakes, or freshwater wetlands. It is naturally replenished by precipitation and naturally lost through discharge to evaporation, discharge to the oceans, and sub-surface (groundwater) seepage.
- Groundwater is the water flowing within **aquifers** (a geological formation that contains or conducts groundwater, especially for supplying water for wells, etc.). The natural input to groundwater is seepage from surface water and the natural outputs are to springs and seepage to bodies of water.
- Desalination is an artificial process by which saline water (usually sea water) is converted to fresh water. Only a very small amount of total water use is supplied by desalination.
- Frozen water found in icebergs has not been found to be a reliable water source. Glacier runoff is a source for surface water.

Introduction

While water may seem limitless and everywhere – after all, you can turn your faucet and out it comes, without appearing to dry up – in fact, in the United States it is a limited resource, and in many parts of the world, even scarce. Add to this the necessity of having water without pollution and you can see that unpolluted water is even harder to find.

Figure 1: Water pollution can cause harmful effects to ecology and human health.

(*Source:* http://commons.wikimedia.org/wiki/Image:Obvious_water_pollution.jpeg, *License:* Creative Commons Attribution 2.5)

Water pollution is the contamination of water bodies by contaminants, mostly anthropogenic, and causing a harmful effect on living organisms. As you explore in this lesson how water pollution affects living things, you will see the urgency in preventing water pollution and discover ways to save water. Perhaps you will be inspired to think of how your household, community, and even world can be a model to others to not take clean water for granted!

Sources of Water Pollution

Although natural phenomena such as storms, algal blooms, volcanoes, and earthquakes can cause major changes in water quality, 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 undergoes a major change in its ability to support the ecological communities it serves.

The primary sources of water pollution can be grouped into two categories, depending on the point of origin:

A. **Point source pollution** refers to contaminants that enter a waterway or water body through a single site. Examples of this includes discharge (also called effluent) of either untreated sewage or wastewater from a sewage treatment plant, industrial effluent, leaking underground tanks, or any other discrete sources of nutrients, toxins, or waste.

B. **Nonpoint source pollution** refers to contamination that does not originate from a single point source, but is often a cumulative effect of small amounts of contaminants (such as nutrients, toxins, or wastes) gathered from a large area. Examples of this include runoff in rainwater of soil, fertilizers (nutrients) or pesticides from an agricultural field, soil from forested areas that have been logged, toxins or waste from construction or mining sites, and even fertilizers or pesticides from your own backyard!

Specific contaminants causing water pollution include a wide variety of chemicals, and pathogens (disease-causing substances). While many of the chemicals and substances that are regulated may be occurring naturally (iron, manganese, etc.) it is often the concentration of the substance that determines what is a

natural component of water and what is a contaminant.

In addition to toxic substances and disease-causing ones, alteration of water's physical chemistry, including acidity, electrical conductivity, and temperature, can also have an effect.

Effects of Water Pollution on Living Things

Water pollutants can have an effect on both the ecology of aquatic ecosystems as well as on human health. Let's examine several types of pollution problems and how they affect both the ecology and human health.

Type of Problem Pollution	Cause	Effect on Ecology	Effect on Human Health and Well-Being
Eutrophication, an increase in chemical nutrients, specifically compounds containing nitrogen or phosphorus, in an ecosystem  **Figure 2:** Lake Valencia, Venezuela, showing vivid green algal blooms, resulting from continued influx of untreated wastewater from surrounding urban, agricultural, and industrial land uses. This contributes to ongoing eutrophication, contamination, and salinization of the lake This pollution impacts the lake's use as a reservoir for the surrounding urban centers and limits opportunities for tourism and recreational uses as well. (*Source:* http://commons.wikimedia.org/wiki/Image:Lake_Valencia,_Venezuela.jpg, *License:* Public Domain)	Frequently a result of nutrient pollution such as the release of sewage effluent and run-off from lawn fertilizers into natural waters, such as rivers or coastal waters	Excessive growth of aquatic vegetation or phytoplankton (or **algal bloom** and decay, and a lack of oxygen, the latter causing severe reductions in water quality, fish, and shellfish  **Figure 3:** Marine debris can adversely impact all sorts of aquatic life. Pictured here is a marine turtle entangled in a net. (*Source:* http://commons.wikimedia.org/wiki/Image:Turtle_entangled_in_marine_debris_(ghost_net).jpg, *License:* Public Domain)	1. Decreases the resource value of rivers, lakes, and estuaries to adversely affect recreation, fishing, hunting, and aesthetic enjoyment. 2. If nitrogen is leached into groundwater, drinking water can be affected because nitrogen concentrations are not filtered out 3. Biotoxins created during algal blooms are taken up by shellfish, such as mussels or oysters; if humans eat these shellfish, then shellfish poisoning can occur and you can become extremely sick, including paralysis and other neurological conditions
Ocean acidification, a process whereby the oceans' uptake of anthropogenic carbon dioxide from the atmosphere causes an ongoing decrease in pH of the oceans (see "Points to Consider," Lesson 25.1: Air Pollution, showing a possible link of air pollutants to water pollution)	Human actions such as land-use changes and the combustion of fossil fuels can lead to an increase in carbon dioxide into the atmosphere, some of which is	Decrease in pH primarily affects oceanic calcifying organisms, such as corals and shellfish; may also directly affect reproduction or other physiology of marine organisms or indirectly cause negative impacts through their food resources	No likely effects

	then absorbed by the oceans		
Transformation of many chemicals, including chlorinated hydrocarbons (carcinogens), especially over long periods of time in groundwater	Used in industrial metal degreasing and electronics manufacturing	As they undergo change in groundwater, can lead to new hazardous chemicals	Such contaminated groundwater can poison drinking water and lead to various human health problems, including cancer
Aquatic debris (trash)	Shipping accidents. landfill erosion, dumping of trash	Aquatic wildlife swallowing plastic bags, strangulation by plastic six-pack rings, entanglement of wildlife in nets  **Figure 4:** Intercepting nonpoint pollution between the source and waterway has been found to be successful. Pictured here, a bioretention cell, or rain garden, in the U.S, is designed to treat polluted storm water runoff from an adjacent parking lot. (*Source:* http://commons.wikimedia.org/wiki/Image:Bioretention_cell_rain_garden_US_winter.jpg, *License:* Public Domain)	Adversely affects recreation and aesthetic enjoyment

Let's close this section and look at a few other effects of water pollution on human health. 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 that burden is attributed to unsafe water supply, sanitation, and hygiene, and is mostly concentrated in the children of developing countries.

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; some viruses and bacteria are water-borne and can be found in drinking water, sewage, contaminated seafood, or unsanitary recreational water; and parasitic infections are usually caused by contaminated drinking water.

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, which prohibited the disposal of any refuse matter into the nation's navigable rivers, lakes, streams, and other bodies of water, unless a person first had a permit. In 1948, the Water Pollution Control Act was passed and gave authority 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, later amended in 1977, to become commonly known as the Clean Water Act. This Act established the basics for regulating discharge of contaminants and established

the authority for the U.S. Environmental Protection Agency (EPA) to implement standards for wastewater discharge by industry. The Clean Water Act also continued requirements to set water quality standards for all surface water contaminants.

More specifically, control of point sources of phosphorus through policy changes have resulted in rapid control of eutrophication. Nonpoint sources, on the other hand, are more difficult to regulate and usually vary with season, precipitation, and other irregular events. Nonpoint sources are especially troublesome because of soil retention, runoff to surface water and leaching to groundwater, and the effect of acid rain (See the Air Pollution lesson).

On the hopeful side, though, cleanup measures have been somewhat successful. For example, Finnish removal of phosphorus started in the mid-1970s has targeted rivers and lakes polluted by industrial and municipal discharges. These efforts have had a 90% efficiency in removal. And with nonpoint sources, some efforts, like intercepting pollutants between the source and water, are successful. Also, creating buffer zones near farms and roads is another possible way to prevent nutrients from traveling into waterways.

Figure 5: A water purification system at Bret Lake, Switzerland. Contaminants are removed and clean new water is created.

(*Source:* http://commons.wikimedia.org/wiki/Image:Usine_Bret_MG_1643.jpg, *License:* Creative Commons Attribution ShareAlike 2.0 France)

In addition, laws regulating the discharge and treatment of sewage have led to dramatic nutrient reductions to aquatic ecosystems, but a policy regulating agricultural use of fertilizer and animal waste must also be imposed. One technique (Soil Nitrogen Testing, or N-Testing) helps farmers optimize the amount of fertilizer applied to crops and at the same time decreases fertilizer application costs, decreases the nitrogen lost to surrounding water resources, and sometimes decreases both.

Actions aimed at lessening eutrophication and algal blooms are usually desirable. However, the focus should not necessarily be aimed at eliminating blooms, but towards creating a sustainable balance that maintains or improves ecosystem health. As you will see in the next lesson (25.3): Natural Resources, sustainable use is a useful concept for the use of resources as well. Can you think of some reasons why?

Ways to Save Water

While we will deal further with this topic in the next Lesson (25.3) on Natural Resources, we will examine here how saving water can also contribute to maximizing clean water for future use. In addition, preventing water pollution is one way of preserving precious water resources.

One way to make sure that water is kept clean and conserved is the use of wastewater reuse or cycling systems, including the recycling of wastewater to be purified at a water treatment plant. By that means, many of the waterborne diseases, caused by sewage and non-treated drinking water, can be prevented.

There are also various means of water purification, whereby contaminants are removed from a raw water source and at the same time create clean new water. Atmospheric water generation is one technology that can provide high quality drinking water by extracting water from the air by cooling the air and thus condensing the water vapor.

Figure 6: Sand processing Mill, near Provodin, Czech Republic. Water is used to wash mined sand, then is drained into tanks, filtered, and recycled.

(*Source:* http://commons.wikimedia.org/wiki/Image:Sand_mining(1).jpg, *License:* GNU-FDL)

Reclaimed water, or recycled water [place Fig. 7 here] that is treated and allowed to recharge the aquifer, is used for non-drinking purposes, so that potable water is used for drinking. This helps to conserve high quality water.

Another way to reduce water pollution and at the same time conserve water is via **catchment management.** This is used to recharge groundwater supplies, helps in the formation of groundwater wells, and eventually reduces soil erosion, one cause of pollution, due to running water.

In addition, both developed and developing countries can increase protection of ecosystems, especially wetlands and riparian zones (areas located on the bank of a waterway, like a river, or sometimes along a lake or tidewater). Not only do these measures conserve biota, but they can also make more effective the natural water cycle flushing and transport that make water systems more healthy for humans. 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?

Lesson Summary

- There are two primary sources of water pollution, point source and nonpoint sources.
- Specific contaminants causing water pollution include chemicals, pathogens, and physical or sensory changes.
- Water pollution can affect both ecology and human health.
- One effect of water pollution is eutrophication, which can cause detrimental effects on aquatic ecosystems as well as on human life, including health.
- Water pollution also causes ocean acidification, which impacts oceanic calcifying organisms.
- 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 discharge of contaminants into water resources and led to dramatic nutrient reductions, but more can be done, especially in areas such as the agricultural use of fertilizer and animal waste.
- Different ways of saving water can also have an impact on our clean water supply.

Review Questions

1. When is water considered polluted? **(Beginning)**

2. Name some sources of nonpoint source pollution. **(Beginning)**

3. Lakes often become polluted as a result of point source pollution release of phosphorus from sewage plants. By what process would the release of phosphorus affect a lake's vegetation growth and how would this in turn affect reductions in water quality and fish and shellfish populations? **(Challenging)**

4. Name some sources of pollutants that can cause waterborne diseases. **(Beginning)**

5. Why are nonpoint sources of pollution so difficult to regulate? **(Intermediate)**

6. Why might floating plastic debris be a problem for marine life? **(Challenging)**

Further Reading / Supplemental Links

Unabridged Dictionary, Second Edition, Random House, New York, 1998.

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

Vocabulary

algal bloom	Excessive growth of aquatic vegetation or phytoplankton as a result of eutrophication.
aquifers	Geological formations that contain or conduct groundwater.
catchment management	Method used to recharge groundwater supplies, help in the formation of groundwater wells, and reduce soil erosion.
desalination	An artificial process by which saline water is converted to fresh water.
eutrophication	An increase in nutrients, specifically compounds containing nitrogen or phosphorus, in an ecosystem.
frozen water	Found in icebergs and glaciers.
nonpoint source pollution	Contaminants resulting from a cumulative effect of small amounts of contaminants gathered from a large area.
ocean acidification	Process whereby the oceans' uptake of anthropogenic carbon dioxide from the atmosphere causes an ongoing decrease in ocean pH.
point source pollution	Contaminants that enter a waterway or water body through a single site.
surface water	Water found in rivers, lakes, or freshwater wetlands.
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.

Review Answers

1. Either when it does not support a human use (like clean drinking water) or cannot support the ecological communities it serves.

2. Soil, fertilizer, and pesticide runoff in rainwater from agricultural fields; soil from deforested areas; toxins or waste from construction or mining sites; fertilizers and pesticides from yards.

3. The process is eutrophication. By this process, the excessive growth of vegetation and its decay cause a lack of oxygen, which causes reductions in water quality and populations of fish and shellfish.

4. Sewage, non-treated drinking water, animal manure, poor disinfection, groundwater contamination, contaminated seafood, and unsanitary recreational water.

5. Because they do not originate from a single point source, but rather from a number of points over a wide area. They also vary with season, precipitation, and other irregular events and are especially troublesome because of soil retention, runoff to surface water and leaching to groundwater, and because of the effects of acid rain.

6. Long-lasting plastic pieces can be swallowed by marine birds and mammals. This results in obstruction of digestive pathways, leading to reduced appetite or even starvation.

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.

Natural Resources

- Define Natural Resources
- Renewable Resources
- Nonrenewable Resources
- Fossil Fuels and Alternative Energy Sources
- Reduce, Reuse, and Recycle

Lesson Objectives

- Explain what natural resources are.
- Describe renewable resources.
- Explain what nonrenewable resources are.

- Discuss the use of fossil fuels as an energy source and what energy sources are available as alternatives.
- Discuss how reducing, reusing, and recycling can help conserve resources.

Check your Understanding

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

Introduction

There are many **natural resources** all about us. Which ones seem the most obvious? Which do you use on a regular basis? Which do you think you could keep using and they would never run out? After thinking about some of these resources, you will see how important an understanding is about what we do use in our daily lives, which of these resources will run out, and what we can do in our daily lives to help prevent them from running out.

As we also examine our energy needs, we will see that fossil fuels are only one source of energy. Just because we use these on a daily basis does not make them necessarily the best choice. What are some of the benefits and detriments to using fossil fuels for energy? Can you think of some alternative energy sources that make the most sense, both from an energy point of view, and also economically? Finally, what can you do, in your home, school, and community to reduce unnecessary use of resources, and to reuse and recycle them when possible?

What are Natural Resources?

A natural resource is a naturally occurring substance which is necessary for the support of life. The value of a natural resource depends on the amount of the material available and the demand put upon it by organisms.

What resources do you use on a daily basis? The ones that may come to mind right away are the ones we already looked at in the last two lessons: air and water. What else is absolutely necessary to your survival? The food you eat seems pretty obvious. Could 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 absolutely necessary for survival and if not, should they be considered resources too?

As you start thinking about what are natural resources for humans, compare these to what are natural resources for organisms other than humans. Perhaps it might seem a bit clearer as to what are resources for other organisms, since their lives are much simpler than ours and they really use resources for survival rather than for making their lives more desirable.

As we will see later in this lesson, of all living organisms, humans have the greatest impact on natural resources. Therefore it is our responsibility to make sure we do everything we can to use resources wisely.

Renewable Resources

A resource is renewable if it is replenished by natural processes at about the same rate at which humans use it up. Examples of this are sunlight and wind, which are very abundant resources and in no danger of being used up. Tides are another example of a resource in unlimited supply, as well as **hydropower**, which is renewed by the Earth's hydrologic cycle.

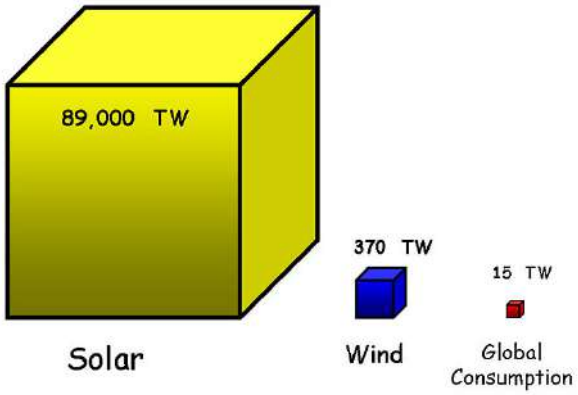

Figure 1: Solar radiation and wind energy are considered renewable resources because availability of both far exceeds our rate of consumption. 89,000 TW (terawatts) represents the amount of sunlight that falls on the Earth's surface, 370 TW depicts wind energy available, and 15 TW was the global rate of energy consumption in 2004.

(*Source:* http://en.wikipedia.org/wiki/Image:Available_Energy-2.jpg, *Created by:* Frank van Mierlo, *License:* GNU-FDL/CC-BY 2.5)

Figure 2: Wind power, another renewable resource, shown here in a modern wind energy plant.

(*Source:* http://commons.wikimedia.org/wiki/Image:Windenergy.jpg, *Photographer:* Wagner Christian, *License:* CC-BY-SA-2.5)

Based on what you learned in the last two lessons, would you say air and water are renewable resources? They may appear to be, but your knowledge about air and water pollution would tell you that clean air and water are not always so accessible. As we think about other resources, like soils, plants and animals, minerals, and energy resources let's keep in mind about whether these are truly renewable or not.

For example, soils are often considered renewable, but because of **erosion** and mineral depletion, this is not always the case. Living things, like forests and fish, are considered renewable because they can reproduce to replace individuals lost to human consumption. However, overexploitation of these resources can lead to extinction.

Figure 3: Soil (Stagnogley) as a resource, showing a mixture of eroded rock, minerals, ions, partially decomposed organic material, water, air, roots, fungi, animals, and microorganisms, formed over thousands, possibly millions of years.

(*Source:* http://en.wikipedia.org/wiki/Image:Stagnogley.jpg, *Photographer:* User HolgerK, *License:* Public Domain)

Also think about at what costs resources can be renewed. If something can be renewed, but at great cost economically or ecologically, is that resource still considered renewable? Perhaps a better way to put this is, does it make sense to renew a resource at great cost? If you're thinking that this discussion is leading up to energy resources, you would be right!

For example, energy resources derived from living things, such as ethanol, plant oils, and methane, are considered renewable, but the environmental costs are not always adequately considered. We will be discussing fossil fuels and alternative energy sources further in this lesson.

Other renewable materials would include **sustainable** (at a rate which meets the needs of the present without impairing future generations from meeting their needs) harvesting of wood, cork, and bamboo, as well as sustainable harvesting of crops. Also, metals and other minerals are sometimes considered renewable because they can be recycled, and are not destroyed when they are used.

Nonrenewable Resources

A **nonrenewable resource** is a natural resource that exists in fixed amounts (relative to our time frame) and can be consumed or used up faster than it can be made by nature. It cannot be regenerated or restored on a time scale compared to its consumption. Two main types of nonrenewable resources are fossil fuels and nuclear power.

- **Fossil fuels,** such as petroleum, coal, and natural gas:

1. Have formed from plant remains (for coal) and phyto- and zoo-plankton remains (for oil) over periods from 50 to 350 million years ago!

2. Has been estimated that 20 metric tons of phytoplankton produce one liter of gasoline!

3. Have been consuming fossil fuels for less than 200 years, yet remaining reserves of oil can supply our needs for only 45 years; of gas, for only 72 years; and of coal, for 252 years

- **Nuclear power**

1. Limited uranium fuel supplies; could last 70 years at current rates of use.

2. Known and unknown reserves are probably much larger.

3. New technologies could make some reserves more useful.

Population growth; industrialization, especially in developing countries; and advances in technology place increasing pressures on how fast we consume natural resources. An unequal distribution of wealth, technology, and energy use suggest that developing nations will even further their increase of demands on natural resources.

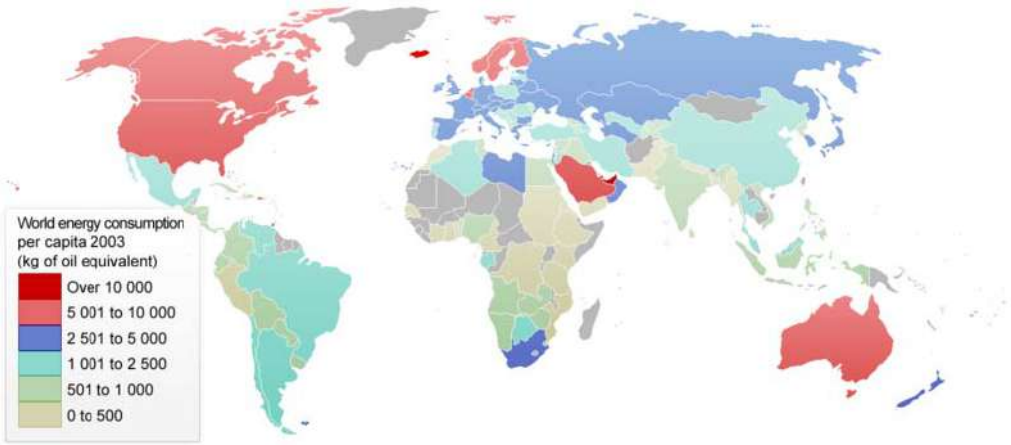

Figure 4: Per capita energy consumption (2003) shows the unequal distribution of wealth, technology, and energy use.

(*Source:* http://commons.wikimedia.org/wiki/Image:Energy-consumption-per-capita-2003.png, *Created by:* User SG, *License:* GFDL, CC-BY-SA-2.5)

That is not to say that all is doom and gloom either. Improvements in technology, conservation of resources, and controls in population growth could all help to lessen the demand on natural resources.

Fossil Fuels and Alternative Energy Sources

As you learned in the section on nonrenewable resources, fossil fuels, such as petroleum, coal, and natural gas, exist in fixed amounts, take millions of years to form naturally, and cannot be replaced as fast as they are consumed. They range from very volatile (explosive) materials like methane, to liquid petroleum to nonvolatile materials like coal.

It was estimated in 2005 that 86% of primary energy production in the world came from burning fossil fuels. Concern about fossil fuels is one of the causes of regional and global conflicts, and the production and use of fossil fuels raise concerns about the environment.

A global movement toward the generation of alternative energy sources, which are renewable, is therefore under way to help meet increased energy needs. Some of these, like solar radiation, wind energy, and hydropower, were mentioned briefly in the section on renewable resources. Let's discuss these and others now in more detail.

- **Solar power** involves using solar cells to convert sunlight into electricity. When sunlight hits solar thermal panels, it is converted to heat water or air. It can also be used to heat water (producing steam) via a parabolic mirror, or it can be used for passive solar heating of a building simply by passing through windows.

Figure 5: An example of solar power, using solar cells to convert sunlight into electricity.

(*Source:* http://commons.wikimedia.org/wiki/Image:Solar_cells.jpg, *Author:* Mihael Simonic, *License:* CC-BY-SA-3.0, 2.5, 2.0, 1.0)

- **Wind power,** the conversion of wind energy into forms such as electricity via wind turbines, is only used for less than 1% of the world's energy needs. However, growth in harvesting wind energy is rapid, with recent annual increases of more than 30%.
- Hydropower uses the energy of moving water to turn turbines or water wheels, which drive a mechanical mill or an electric generator. Today, the largest use of hydropower is for electric power generation, which allows low cost energy to be used at long distances from the water source. Electricity can also be generated constantly, as long as sufficient water is available, it produces no primary waste or pollution, and it is a renewable resource.

Figure 6: Small hydropower plant, Buchholz, Switzerland.

(*Source:* http://commons.wikimedia.org/wiki/Image:060929_KW_Buchholz_001.jpg, *Author:* User, *License:* GNU-FDL)

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. Keep in mind as we do so what you think the best alternatives

might be.

- Geothermal power uses the natural flow of heat from the earth's core to produce steam, which is used to drive turbines, which, in turn, power electric generators.
- Biomass production involves using garbage or other renewable resources such as corn or other vegetation to generate electricity. When garbage decomposes, the methane produced is captured in pipes and burned to produce electricity. Advantages of these types of energy include using organic waste products from agriculture; biomass is abundant and is generally renewable.
- Power can be extracted from Moon-gravity-powered tides by locating a water turbine in a tidal current. The turbine can turn an electrical generator, or a gas compressor, which can then store energy until needed
- Nuclear power plants use nuclear fission to generate energy inside a nuclear reactor. The released heat, heats water to create steam, which spins a turbine generator, producing electricity.

Figure 7: Dam of the tidal power plant on the estuary of the Rance River, Bretagne, France

(*Source:* http://commons.wikimedia.org/wiki/Image:Rance_tidal_power_plant.jpg, *Created by:* User:Dani 7C3, *License:* GNU-FDL)

Figure 8: Aerial photo of the Bruce Nuclear Generating Station near Kincardine, Ontario

(*Source:* http://commons.wikimedia.org/wiki/Image:Bruce-Nuclear-Szmurlo.jpg, *Author:* Chuck Szmurlo, *License:* GNU-FDL)

Now that we have reviewed the pros and cons of fossil fuels and alternative energy sources, what type or types do you think makes the best use of the natural resources available to us? As we move into our last section, also think about how reducing waste and reusing and recycling resources can help us reach our goals for energy production as well.

Reduce, Reuse, and Recycle

When we think of **reducing,** we're talking about reducing our output of waste. That could also mean cutting down on use of natural resources. Reusing and recycling are other ways we can cut down on use of 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; sometimes buying larger may be a better deal, cost-wise, but make sure you will really finish what you buy
- To minimize usage of electricity, turn lights off when not using and replace burned out bulbs with ones that are more ecologically efficient
- Reduce water use by turning off faucets when not using water; use low-flow shower heads, which save on water and use less energy, since less water is being heated; use low-flush and composting toilets
- Purchase water-efficient crops, which require little or no irrigation
- Put kitchen and garden waste into a compost pile
- In the summer, change filters on your air conditioner and keep your thermostat at a temperature as warm as you can tolerate; in winter, make sure your furnace is working properly, keep the temperature as cold as you can tolerate, and make sure there is enough insulation on windows and doors
- Mend broken or worn items, when feasible
- Walk or bicycle to destinations, when possible, rather than using an automobile, in order to save on fuel costs and to cut down on emissions
- When buying a new vehicle, check into hybrid and semi-hybrid brands (many new ones are coming rapidly onto the market) to cut down on gas mileage
- Consider which makes more sense – to spend valuable gas to go further to recycle, for example, or to sometimes use the trash instead of recycling

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 (think about ways these might be incorporated into your home) include:

- Use of gray water – water which has been used for laundry or washing, for example, can be used to water the garden or flush toilets * At the town level, sewage water can be used for fountains, watering public parks or golf courses, fire fighting, and irrigating crops that will be peeled or boiled before use
- Catching of runoff, which will also slow nonpoint source pollution and erosion – rain barrels next to buildings, recharge pits to re-fill aquifers

Perhaps you can think of some other ways to reuse resources!

Now we move on to **recycling.** Sometimes it may be difficult to understand the differences between reuse and recycling. Recycling differs in that it breaks down the item into raw materials, which are then used to make new items, whereas reusing uses the same item again. Even though recycling requires extra energy, it does often make use of items which are broken, worn out, or otherwise unsuitable for reuse.

The things that are commonly recycled include aggregates and concrete, batteries, biodegradable waste, electronics, iron and steel, aluminum, glass, paper, plastic, textiles, timber, industrial breaking of ships, and tires. Each type of recyclable requires a different technique. Perhaps you or your school could arrange for a trip to a recycling plant!

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, according to your local guidelines; have containers set up for easy placement
- See if your school recycles; if not perhaps you and some friends could start a recycling, or ecology, club, or organize efforts to better recycling goals

In order to judge the environmental and economic benefits of recycling, the cost of this process must be compared to the costs of extracting the original resource. In order for recycling to make economical sense, there usually must be a steady supply of recyclables and constant demand for the reprocessed products. Government legislation can stimulate both of these. As with all environmental issues, individuals can communicate with their representatives to make sure their wishes are heard.

The amount that an individual wastes is small in proportion to all waste produced by society. Yet all small contributions, when added up, can make a difference. In addition, influence on policy can be exerted in other areas. Awareness by you and your family, for example, of the impact and power of certain purchasing and recycling decisions can influence manufacturers and distributors to avoid buying products that do not have eco-labeling, are currently not mandatory, or that minimize the use of packaging.

Lesson Summary

- A natural resource is a naturally occurring substance which is necessary for the support of life.
- Resources are either renewable or nonrenewable.
- Examples of renewable resources include sunlight, wind tides, and hydropower.
- Some resources may seem to be renewable, but may have some limits, as to how accessible a nonpolluted resource is and what effect overexploitation of the resource has.
- Some renewable materials include the sustainable harvesting of certain products.
- Nonrenewable resources include fossil fuels and nuclear power.
- Burning of fossil fuels causes harmful effects in the environment and can lead to regional and global conflicts.
- There are a number of renewable energy sources which offer alternatives to the burning of fossil fuels; they include solar radiation; wind energy; hydropower; geothermal power; biomass, biofuels, and vegetable oil; tidal power; nuclear energy; and fusion power.
- There are pros and cons to all alternative energy sources.
- Reducing waste and the reusing and recycling of resources can help save natural resources as well as help us reach our goals for energy production.

- There are many things you can do in your household and community towards the goals of reducing, reusing, and recycling; individual efforts can also add up to make a difference nationally, and even internationally.
- Awareness of wise resource use at the consumer level can influence decisions at the manufacturing and distributing levels.
- Government legislation is also important to enforce these changes; it is up to individuals to communicate to their representatives the carrying out of wise use of natural resources, and to vote for those leaders who stand for sound ecological practices.

Review Questions

1. Under what conditions is a resource renewable? **(Beginning)**

2. Why must some natural renewable resources, such as geothermal power, fresh water, timber, and biomass be carefully managed? **(Challenging)**

3. Why is nuclear power considered a nonrenewable resource? **(Beginning)**

4. With resources that have limited supplies, what human factors put increasing pressure on how fast we consume such resources? **(Intermediate)**

5. What are the main disadvantages to the burning of fossil fuels as an energy source? **(Challenging)**

6. What two advantages do solar power, wind power, and hydropower all have in common? **(Intermediate)**

Further Reading / Supplemental Links

Unabridged Dictionary, Second Edition, Random House, New York, 1998.

Natural Resources 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://www.epa.gov/region5/students/waste.htm

http://en.wikipedia.org/wiki/Water_conservation

Vocabulary

biofuels	The production of fuels, such as wood or ethanol, from biomass.
biomass	Use of garbage or other renewable resources such as corn or other vegetation to generate electricity.
erosion	Process by which the surface of the Earth is worn away by the action of winds, water, waves, glaciers, etc.
fossil fuels	Formed from plant or animal remains over periods from 50 to 350 million years ago and used to produce sources of energy, such as petroleum and coal.
fusion power	The production of atomic energy by the process of nuclear fusion.
geothermal power	The use of the natural flow of heat from the Earth's core to produce steam.
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.
sustainable	A rate which meets the needs of the present without impairing future generations from meeting their needs.
tidal power	Power generated from tidal currents.
wind power	The conversion of wind energy into electricity via wind turbines.

Review Answers

1. If it is replenished by natural processes at about the same rate at which humans use it up.

2. To avoid exceeding the environment's capacity to replenish them.

3. Because there are limited uranium fuel supplies.

4. Population growth; industrialization, especially in developing countries; and advances in technology.

5. Fossil fuels are nonrenewable resources; petroleum-powered vehicles are very inefficient and the heat and gaseous pollution emissions harm our environment; combustion of fossil fuels leads to the release of pollution into the atmosphere, with resulting increases in global warming, acid rain; and harmful effects on people's health; reliance on fossil fuels can lead to regional and global conflicts

6. They are all renewable resources and produce no water or air pollution.

Points to Consider

- Minimizing use of some resources helps to preserve habitats; for example, conservation of human water use helps to preserve freshwater habitats for local wildlife and migrating waterfowl.
- Habitats are another resource for both humans and other organisms. Now that we have considered conservation of natural resources, we will move on in the next lesson to examining the effects of habitat destruction and how to protect habitats. Why do you think this is an important topic?
- Discuss how the protection of natural resources may be important for biodiversity.
- Protection of natural resources, including habitats, is also important to avoid dire consequences, such as extinction of species. Discuss why.

Habitat Destruction and Extinction

- Causes of Habitat Destruction
- Why Habitat Destruction Threatens Species
- Other Causes of Extinction

- Importance of Biodiversity
- Protecting Habitats

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.

Check your Understanding

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

Figure 1: A sampling of some of the wide diversity of animal species on earth.

(*Source:* http://commons.wikimedia.org/wiki/Image:Animal_diversity_October_2007.jpg, *Collage by:* User Justin, *License:* CC-BY-SA-3.0)

Figure 2: Coral reefs are one of the biomes with the highest biodiversity on earth.

(*Source:* http://commons.wikimedia.org/wiki/Image:Nwhi_-_French_Frigate_Shoals_reef_-_many_fish.jpg, *Photographer:* James Watt, *License:* Public Domain US)

Figure 3: This tropical rain forest demonstrates another biome having one of the greatest biodiversities on earth.

(*Source:* http://commons.wikimedia.org/wiki/Image:Rain_Forest_of_El_Yunque,_Puerto_Rico.jpg, *Photographer:* Alessandro Cai, *License:* Public Domain)

Introduction

From a human point of view, a habitat is the environment where you live, go to school, places where you go to have fun, and other places you regularly visit. Maybe if we think of habitat in this way we will have a better sense of other species' habitats and a better appreciation for how valuable a habitat is to its occupants.

When we likewise consider habitat destruction, we might evaluate more carefully human influences such as land clearing and introduction of non-native species of plants and animals and how this can have even catastrophic effects, like **extinction** of species, some of which give us great beauty and some of which have medicinal or other useful qualities! In human terms, how would we feel if someone came in and radically changed our habitat, and either drove us out or worse yet, caused us to eventually die?

Figure 4: Slash-and-burn agriculture, shown here in southern Mexico, clears land for agriculture.

(*Source:* http://commons.wikimedia.org/wiki/Image:Lacanja_burn.jpg, Photograph: Jami Dwyer, *License:* Public Domain-User)

Figure 5: An exotic species, the brown tree snake, hitch-hiked on an aircraft to the Pacific Islands, causing the extinctions of many bird and mammal species which had evolved in the absence of predators.

(*Source:* http://commons.wikimedia.org/wiki/Image:Brown_tree_snake_Boiga_irregularis_2_USGS_Photograph.jpg, *License:* Public Domain-USGOV-INTERIOR-NPS)

In this lesson, we will also examine other causes of extinction besides habitat destruction and the importance of biodiversity. Finally, we will see, that as our planet becomes more threatened and as we see how this also impacts the human species, human awareness of these issues has led to measures, such as habitat protection, that can help all of the earth's inhabitants.

Causes of Habitat Destruction

Clearing some habitats of vegetation for purposes of agriculture and development is a major cause of habitat destruction or loss. Within the past 100 years, the area of cultivated land worldwide has increased 74%. Land for the grazing of cattle has increased 113%! Agriculture, alone, has cost the United States 50% of its **wetlands** and 99% of its **tallgrass prairies**. Native prairie ecosystems, with their thick fertile soils,

deep-rooted grasses, diversity of colorful flowers, burrowing prairie dogs and burrowing owls, herds of bison and pronghorn antelope, and other animals, are virtually extinct.

Figure 6: Wetlands such as this one in Cape May, New Jersey, filter water and protect coastal lands from storms and floods.

(*Source:* http://commons.wikimedia.org/wiki/Image:Wetlands_Cape_May_New_Jersey.jpg, Photograph: Anthony Bley, *License:* Public Domain US Army USACE)

Figure 7: Big bluestem grasses as tall as a human were one of the species of the tallgrass prairie, largely eliminated by agricultural use.

(*Source:* http://commons.wikimedia.org/wiki/Image:Andropogon_gerardii.jpg, *License:* Public Domain US Government)

Figure 8: Herds of bison also made up part of the tallgrass prairie community.

(*Source:* http://commons.wikimedia.org/wiki/Image:Tallgrass_Prairie_ Nature_Preserve_in_Osage_County.jpg, Photograph: Reservoirhill, *License:* Public Domain User)

Another habitat that is being rapidly destroyed is forests, most significantly tropical rainforests, one of the two major ecosystems (or biomes) with the highest biodiversity on earth. The largest cause of deforestation today is **slash-and-burn agriculture** (See Fig. 4), practiced by over 200 million people in tropical forests throughout the world. Depletion of the thin and nutrient-poor soil (even so, biodiversity here is high – can you guess why?) often results in people abandoning the forest within a few years, and subsequent erosion can lead to **desertification** (a process leading to production of a desert of formerly productive land [usually at least semi-arid]).

Half of the earth's mature tropical forests are gone. At current rates of deforestation, all tropical forests will be gone by 2090. Poverty, inequitable land distribution, and overpopulation combine in many developing countries to add pressure to habitats which are already stressed. Use of firewood, charcoal and manure for cooking and other energy needs, and waste of crops further degrade environments, threatening biodiversity through habitat loss. Other causes of habitat destruction include poor fire management, invasion of pest and non-native species, overfishing, mining, pollution, and storm damage.

Why Habitat Destruction Threatens Species

Agriculture, forestry, mining, and urbanization have disturbed over half of the earth's land. Inevitably, species disappear and biodiversity decreases. Habitat destruction is currently ranked as the most important cause of extinction of species worldwide.

The destruction of a species' habitat may alter the landscape to such an extent that the species is no longer able to survive and becomes extinct. This may occur directly, such as the environment becoming toxic, or indirectly by limiting a species' ability to compete effectively for diminished resources or with a new species.

Habitat destruction through pollution can kill off a species very rapidly, by killing all living members by contamination or sterilization. It can also occur over longer periods at lower toxicity levels, by affecting life span, reproductive capability, or competitiveness.

Habitat destruction can also occur physically by elimination of certain niches in a habitat. For example, elimination of dense tropical rainforest and replacement with open pastureland can affect certain species. Thus, a fern that depends on dense shade for protection from direct sunlight can no longer survive without trees to shelter it. Another example of this is the destruction of ocean floors by bottom trawling.

Fewer resources or introduction of new competitor species often accompany habitat destruction. Global warming has allowed some species to expand their ranges, sometimes into those of species that previously

occupied that area. If these new competitors are predators, they may directly affect prey species, or they may compete with other species for limited resources. If such resources as water and food are limited during habitat destruction, then species can become extinct.

Another type of habitat that is being rapidly destroyed is the wetland. By the 1980s, over 80% of all historic wetlands in seven states of the U.S. were filled, at which time Congress acted to create a policy of “no net loss” of wetlands. In Europe, extensive loss of wetlands has resulted in loss of biodiversity. For example, many bogs in Scotland have been drained or developed because of human population expansion. Over half of the Portlethen Moss in Aberdeenshire, for example, has been lost and a number of species, such as the great crested newt, are no longer present.

Another example of species loss due to habitat destruction occurred on Madagascar’s central highland plateau. From 1970 to 2000, slash and burn agriculture eliminated about 10% of the country’s total native biomass and converted it to a barren wasteland. Adverse effects included widespread gully erosion that produced heavily silted rivers and eliminated a large amount of usable fresh water. Much of the riverine ecosystems of several large west-flowing rivers were also destroyed, several fish species have been driven to the edge of extinction, and some coral reef formations in the Indian Ocean are effectively lost.

Practices such as clear-cutting of old growth forests, strip mining, and driftnet fishing can go beyond the harvesting of a single species or resource to degrade entire ecosystems. Overexploitation happens on the level of genes and ecosystems as well as individual species. Forest plantations, fish hatcheries and farms, and intensive agriculture reduce both species diversity and genetic diversity within species.

Figure 9: Strip coal mining, pictured here, has degraded the entire ecosystem.

(*Source:* http://commons.wikimedia.org/wiki/Image:Strip_coal_mining.jpg, Photograph: Stephen Codringto - Available to download and order at his personal website, *License:* CCA 2.5)

Other Causes of Extinction

One of the primary causes of extinction (already mentioned briefly) is introduction of exotic species (alien or **invasive species**). Both intentionally and inadvertently, humans have introduced various species into habitats, which already have their own native species. As a result, these invasive species have often had very harmful effects on the native species.

As long ago as 3500 BP, ships from Polynesian times brought crop species and domesticated animals as well as stowaway rats and snakes. Recently, cargo ships have transported zebra mussels, spiny waterfleas, and ruffe into the Great Lakes via ballast water. Europeans brought purple loosestrife and European buckthorn to North America to beautify their gardens.

Figure 10: These zebra mussels, an introduced species, colonize most manmade and natural surfaces, including native mussels. 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.

(*Source:* http://commons.wikimedia.org/wiki/Image:Zebra_mussel_infestation_Ormond_Lock.jpg, Author: Laurie Driver, *License:* Public Domain US Army USACE)

Other invasive species have included the European starling, introduced by Shakespeare enthusiast Eugene Schieffelin to Central Park in the 1890s, because he thought Americans should experience every bird mentioned in the works of Shakespeare. This species is a hole-nesting species and has affected native species where it has been introduced (i.e. Australia, North America) because of competition for nest sites. Other examples of invasive species include the introduction of the cane toad, introduced to control the cane beetle, and the brown tree snake (See Fig. 6).

Many of these exotic species, away from the predation or competition of their native habitats, have unexpected and negative effects in the new ecosystems. Introduced species can disrupt food chains, carry disease, prey on native species directly, and as we have already seen, out-compete natives for limited resources. All of these effects can lead to extinctions of the native species. In addition, some introduced species hybridize with native species, resulting in **genetic pollution,** which weakens natural adaptations.

Another major cause of extinction is global climate change. As we have already seen earlier in this chapter, our increasing reliance on fossil fuels in altering the earth's atmosphere, and as a result, climate. This has many effects, some of which we have already discussed, but on a species level, these other effects, including changing air and water temperatures, rainfall patterns, and salinity threaten species adapted to pre-warming conditions and thus result in a decline of biodiversity globally.

Overpopulation (already mentioned previously), along with developments in technology, have added tremendous pressure to resource and land use and add to all of the previously mentioned threats to biodiversity. The highest rates of population growth are often in third world tropical countries where biodiversity is also highest. Therefore pressures from local populations as well as increased pressure from incoming tourists in some areas can produce enormous consequences for the local plant and animal ecosystems.

A final major cause of extinction is pollution, and mentioned earlier in this lesson. Pollution adds chemicals, noise, heat, or even light beyond the capacity of the environment to absorb them without major harmful effects on all kinds of organisms.

One good example of a toxic chemical affecting a species was the use of the pesticide, DDT. Use of this pesticide in the eastern United States resulted in the effect of **biological magnification** (where many synthetic

chemicals concentrate as they move through the food chain, so that toxic effects are multiplied), with the result of the disappearance of the peregrine falcon from this area. As a result, DDT was banned in the U.S.

Pollution continues to contribute to habitat destruction and decreasing biodiversity worldwide, especially in developing countries. Air pollution knows no boundaries and as we have already seen, its effects on acid rain, ozone depletion, and global warming all affect biodiversity.

Water pollution especially threatens vital freshwater and marine resources throughout the world. Specifically, industrial and agricultural chemicals, waste, acid rain, and global warming threaten waters, essential for all ecosystems. Finally, soil contamination, mostly from toxic industrial and municipal wastes, salts from irrigation, and pesticides from agriculture all degrade soils, the foundation of terrestrial ecosystems and their biodiversity.

Figure 11: Soil contamination caused by underground storage tanks containing tar.

(*Source:* http://commons.wikimedia.org/wiki/Image:Soilcontam.jpg, Copyright holder; *License:* CC-BY-SA 3.0,2.5,2.0,1.0)

Outside the developed world, pollution controls often lag far behind those of the U.S. and Europe, and some developing nations, like China, are rapidly increasing their levels of pollution. Many pollution problems are also present in industrialized nations as well; industry and technology add nuclear wastes, oil spills, thermal pollution from wastewater, acid rain, and more to the challenges facing the earth's biodiversity.

Figure 12: An oiled bird from an oil spill in San Francisco Bay. About 58,000 gallons of oil spilled from a South Korean-bound container ship when it struck a tower supporting the San Francisco-Oakland Bay Bridge in dense fog, 11/07.

(*Source:* http://commons.wikimedia.org/wiki/Image:Oiled_bird_3.jpg, Photograph: Mila Zinkova, *License:* CC-BY-SA-3.0,2.5,2.0,1.0)

Figure 13: A highly endangered Macquarie perch specimen was caught on a lure with barbless hooks in a high altitude upland river and was carefully released. This species is now extinct in most of its upland river habitats due to introduced trout species in the same habitats. Siltation from agricultural practices and flow regulation and thermal pollution by dams have also caused the extinction of this species in some upland rivers.

(*Source:* http://commons.wikimedia.org/wiki/Image:800px-Macquarie_perch.jpg, *License:* GNU-FDL)

Importance of Biodiversity

Does it matter if we are losing thousands of species each year, when the earth holds millions and life has been through extinction before? The answer is yes; it matters even if we consider only direct benefits to humans. But there are also lots of indirect benefits, also known as ecosystem services, in addition to benefits to other species as well.

Biodiversity is important for a number of reasons. Economically, direct benefits include the potential to diversify our food supply; increase resources for clothing, shelter, energy, and medicines; a wealth of efficient designs which could inspire new technologies; models for medical research; and an early warning system for toxicity.

In our food supply, monocultures (large-scale cultivation of single varieties of single species) are very vulnerable to disease. As recently as 1970, blight affected the corn belt where 80% of maize grown in the U.S. was of a single type. Contemporary breeders of various crop species increase the genetic diversity by producing hybrids of crop species with wild species adapted to local climate and disease.

Figure 14: 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 have the potential for increased productivity, nutritional value, adaptation to local climates, and resistance to local diseases.

(*Source:* http://commons.wikimedia.org/wiki/Image:GEM_corn.jpg, Photograph: Keith Weller of the Agricultural Research Service, *License:* Public Domain USDA ARS)

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. In addition to these above raw materials for industry, we use animals for energy and transportation, and biomass for heat and other fuels.

According to one survey, 57% of the most important prescription drugs come from nature (bacteria, fungi, plants, and animals), yet only a fraction of species with medicinal properties have been examined. **Bionics**, also known as biomimetics or biomimicry, uses organisms as models for engineering inspiration. For example, rattlesnake heat-sensing pits suggest infrared sensors and Zimbabwe's Eastgate Centre was inspired by the air-conditioning efficiency of a termite mound.

Figure 15: Aspirin originates in the bark of the white willow, pictured here.

(*Source:* http://commons.wikimedia.org/wiki/Image:Salix_alba_008.jpg, Photography: User Willow, *License:* CC_BY-SA.2.5)

Figure 16: Design of this 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 (See Figure 17).

(*Source:* http://commons.wikimedia.org/wiki/Image:Harare_secondst.jpg, *Photograph:* Damien Farrell, *License:* GFDL/CC-BY-SA-2.5, 2.0, 1.0)

Figure 17: The air-conditioning efficiency of this termite mound was the inspiration for the Eastgate Centre (Figure 16).

(*Source:* http://commons.wikimedia.org/wiki/Image:Somalia_termitstack_B%C3%85n.jpg, Photograph: Bengt Olof ARADSSON, *License:* GFDL/CC-BY-2.5)

At an ecological level, biodiversity provides ecosystem stability and productivity; the maintenance and renewal of soils, water supplies, and the atmosphere; nitrogen fixation and nutrient recycling; pollination, pest, and disease control; and waste disposal. Other benefits include the cultural, aesthetic, and spiritual values of biodiversity and its importance to many types of recreation.

Biodiversity is critically important for us and for the earth, and it is declining at a fast rate. What can you do to help to protect habitats, which are at the crux of biodiversity?

Protecting Habitats

There are lots of things we can do to protect biodiversity, some of which we've touched upon in prior sections of this lesson, including the need to reduce, reuse, and recycle of all resources; not contributing to introduction of invasive species; practicing sustainable management on your own land; adopting and spreading sustainable perspectives and philosophy; learning more about biodiversity; and taking action as a citizen to make sure biodiversity is protected.

We are going to focus now on what can be done, or has already been done, to protect habitats, the actual physical spaces, themselves, which, as we have seen, contributes to maintaining and increasing biodiversity. What do you think helps protect habitats and what can you do to help protect them?

Perhaps if you've taken a trip, or even in your own community, you've enjoyed some time exploring and enjoying the outdoors. Think of the areas you might have visited that seemed, even somewhat, undisturbed, in other words, areas where there was little disturbance from human influence. Maybe you were able to enjoy scenic landscape, enjoy some quiet where you could hear the sounds of nature, or maybe see very

few people. Sometimes we need to get away from all the noise and pollution and be in a quiet place, not only to enjoy and appreciate the nature around us, but even to experience some quiet within ourselves.

If you think back on some of these places, what characteristics of the actual physical location did you observe? Does it require a huge amount of space to protect a habitat, or will even a small space do? From what we know about habitats and species, how much space is enough to ensure species will not become extinct or threatened?

There may not be a clear answer to this. It really depends on the species involved and what its requirements are. A large mammal, like a species of big cat, who has a large range, may need more land than a much smaller species, like a snail. Often, if we protect the habitat of a keystone species (See the Communities chapter), which usually has a larger habitat than all the other species in that community, then all the other habitats of other species within that community will be protected as well.

The kinds of protected areas, we are talking about, that help protect species are usually in the form of national parks, nature reserves, state parks, and even community and town parks. Sometimes it is important to also protect interconnecting corridors between parks or reserves to protect those species that travel from one area to another for purposes of breeding or feeding, for example.

Even though many of these protected areas are already in existence, there is much you can do as a citizen to make sure these areas stay protected and to help create other areas that need to be protected. Some of the things you can do are to get involved with your community or town's efforts to protect local areas. Even if you don't understand everything that goes on at a town meeting, you might want to attend one sometime to learn about some of the important local environmental issues that are being discussed.

Join local groups which monitor ecosystem health, such as Frog Watch, River Watch, or bird counts. Some national organizations have programs, such as National Audubon's Great Backyard Bird Count and Operation Feeder Watch, and similar programs run by the National Wildlife Foundation, where you can keep track of what you see in your backyard and thereby contribute to a greater understanding of biodiversity.

Become aware of some of the habitat issues on a state and national level. Maybe you can write or e-mail your state representatives, for example, to urge them to help protect areas large enough to accommodate migration, flooding, buffer zones, pollution from nearby development, and even people and their activities. It is a challenge to balance the needs of an increasing population with natural resource needs, but we have to remember that people, as well as wildlife, depend on natural resources to flourish and survive!

Volunteer with local organizations that protect habitat. Help out at cleanup days in your community, where people gather together to pick up trash and make a habitat more hospitable for its inhabitants. Some of these cleanup days are even advertised through your school. Start an ecology club at your school, if there isn't one already, and encourage your friends and classmates to join.

Think about sustainable management even at the level of your own backyard, even if it is a small yard. 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 introduced species? 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, but make sure you keep the feeders well-stocked with food. Similarly, bird baths are useful, especially when temperatures get warm and during dry periods. Use organic or natural pesticides and fertilizers.

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

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.
- Habitat destruction threatens species through pollution, eliminations of niches, availability of fewer resources, and introduction of new species.

- Some habitats affected by destruction include tropical rainforests, wetlands, and coral reefs.
- Introduction of invasive species have caused harmful effects on native species, sometimes resulting in extinction
- Other causes of extinction include pollution, global climate change, and overpopulation.
- Biodiversity is important because it directly affects humans as well as ecosystem benefits and benefits to other species.
- Economically, biodiversity diversifies our food supply; increases resources for clothing, shelter, and energy, and medicines; inspires new technologies; supplies models for medical research and an early warning system for toxicity.
- Because of the importance of biodiversity and habitats, it is vital to do what we can do as citizens to protect habitats; these include continued protection in national parks, reserves, and other green areas; creation of new areas; communicating with representatives about these issues; volunteering with local organizations which have these goals in mind; and practicing sustainable practices, even at the level of your own backyard! Most importantly, educate others about the importance of habitat protection.

Review Questions

1. What is the largest cause of deforestation today? **(Beginning)**

2. How can habitat destruction through pollution kill a species over a long period of time? **(Intermediate)**

3. Why do introduced exotic species have unexpected and negative effects in the new ecosystems? **(Intermediate)**

4. Why are so many exotic species now being introduced either accidentally or intentionally to native habitats? **(Challenging)**

5. Explain how biological magnification played a role in the disappearance of the peregrine falcon from the eastern U.S. **(Challenging)**

6. Loss of biodiversity limits our ability to increase the genetic diversity of crops. What is the advantage of producing hybrids of crop species with wild species adapted to local climate and disease? **(Intermediate)**

7. What are some of the things you can do to have a sustainably managed backyard? **(Intermediate)**

Further Reading / Supplemental Links

Unabridged Dictionary, Second Edition. Random House, New York, 1998.

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

Vocabulary

biodiversity	The number of different species or organisms in an ecological unit (i.e. biome or ecosystem).
biological magnification	The process in which synthetic chemicals concentrate as they move through the food chain, so that toxic effects are multiplied.
bionics	Engineering which uses the design of biological organisms to develop efficient products.
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.
genetic pollution	Hybridization or mixing of genes of a wild population with a domestic population.
habitat	The ecological or environmental area where a particular species lives and the physical environment to which it has become adapted and in which it can survive.
habitat destruction	The process in which a natural habitat is made functionally unable to support the species originally present.
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.
tallgrass prairies	Native prairie ecosystems with thick fertile soils, deep-rooted grasses, and other characteristic species.
wetlands	A habitat that has a defined soil with characteristic vegetation and hydrology.

Review Answers

1. Slash-and-burn agriculture.

2. At lower toxicity levels, by affecting life span, reproductive capability, or competitiveness.

3. The exotic species are away from the predation or competition of their native habitats.

4. Because of globalization and increasing tourism.

5. Use of the pesticide, DDT, was concentrated as it moved through the food chain. Since the peregrine falcon was at the top of the food chain it had the greatest concentration of the pesticide and eventually disappeared from the area.

6. Hybridization increases the genetic diversity of crop species resulting in the potential to increase productivity, nutritional value, adaptation to local climates, and resistance to local diseases.

7. Start a compost pile, plant native and drought-tolerant species of shrubs and trees, attract native species of birds with feeders and birdbaths, use organic or natural pesticides and fertilizers.

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