

# BOY SCOUT TROOP 236

## Environmental Science Merit Badge

1. Make a time line of the history of environmental science in America. Identify the contribution made by the Boy Scouts of America to environmental science. Include dates, names of people or organizations, and important events.
2. Define the following terms and describe the relationships among them: population, community, ecosystem, biosphere, symbiosis, niche, habitat, conservation, threatened species, endangered species, extinction.
3. Do ONE activity in EACH of the following categories (using the activities outlined in this handout as the bases for planning and carrying out your projects):
  - a. Ecology
    - (1) Conduct an experiment to find out how living things respond to changes in their environments. Discuss your observations with your counselor.
    - (2) Conduct an experiment illustrating the greenhouse effect. Keep a journal of your data and observations. Discuss your conclusions with your counselor.
  - b. Air Pollution
    - (1) Perform an experiment to test for particulates that contribute to air pollution. Discuss your findings with your counselor.
    - (2) Conduct a study to test the effects of acid rain on plants. Discuss your findings with your counselor.
  - c. Water Pollution
    - (1) Conduct an experiment to show how living things react to thermal pollution. Discuss your observations with your counselor.
    - (2) Conduct an experiment to identify the methods that could be used to mediate (reduce) the effects of an oil spill on waterfowl. Discuss your results with your counselor.
  - d. Land Pollution
    - (1) Conduct an experiment to illustrate soil erosion by water. Take photographs or make a drawing of the soil before and after your experiment, and make a poster showing your results. Present your poster to your patrol or troop.
    - (2) Perform an experiment to determine the effect of an oil spill on land. Discuss your conclusions with your counselor.
  - e. Endangered Species
    - (1) Do research on one endangered species found in your state. Find out what its natural habitat is, why it is endangered, what is being done to preserve it, and how many individual organisms are left in the wild. Prepare a 100-word report about the organism, including a drawing. Present your report to your patrol or troop.
    - (2) Do research on one species that was endangered or threatened but which has now recovered. Find out how the organism recovered, and what its new status is. Write a 100-word report about the species and discuss it with your counselor.
  - f. Resource Recovery
    - (1) Perform an experiment on packaging materials to find out which ones are biodegradable. Discuss your conclusions with your counselor.
    - (2) Find out if your local community has a recycling program in effect.

If it does, find out what items are recycled, and who pays for recycling. If your community does not have a recycling program, write questions for and conduct a survey on recycling. Include questions about attitudes toward recycling, what should be recycled, and your community's willingness to support a recycling program. discuss your findings with your counselor.

4. Build an ecosystem in a bottle. Include soil, plants, fungi, and small animals found in your local environment. Maintain the ecosystem for one week. Observe it daily, and keep a record of your observations. Discuss your observations with your counselor.
5. Choose an outdoor area to study. In your study area do ONE of the following:
  - a. Mark off three study plots of 4 square yards(2 yards by 2 yards or 1 yard by 4 yards) each, and count the number of species found there. Then estimate how much space is occupied by each species found in the plots. Write a report that adequately discusses the biodiversity and population density of your study area. Discuss your report with your counselor.
  - b. Make four visits to the study area, staying for at least 30 minutes each time, to observe the living and nonliving parts of the ecosystem. Keep a journal of your observations, including a discussion of differences noted during the four visits. Write a report on your observations and discuss it with your counselor.
6. Propose a hypothetical construction project in your community and prepare a limited environmental impact statement for the project. Study the area to see what the impact of the project might be upon the living and nonliving parts of the ecosystem.
7. Design a project that would help solve an environmental problem, reduce an environmental impact, or affect environmental awareness in your community. Include plans for a specific project that could be done by your patrol or troop.
8. Discuss three possible careers in the field of environmental science. Identify the education that you would need to pursue ONE of these careers.

### **History of Environmental Science in America (Requirement 1)**

When Native Americans came to North America perhaps 15,000 years ago, they brought with them a reverence for nature. Native Americans saw people as a part of nature. Chief Seattle of the Suquanish Tribe said in 1854, "This we know. The earth does not belong to man; man belongs to the earth... All things are connected, like the blood which unites one family... Man did not weave the web of life; he is merely a strand in it. Whatever he does to the web, he does to himself."

Europeans came to North America with a different attitude toward nature and their place in nature. Many Europeans believed that nature existed to serve people. They looked upon the abundant natural resources of North America as things to be used to meet humankind's needs. Because there were forests as far as the eye could see, teeming with game animals, early settlers could---and did--- use the natural resources as if they were limitless.

As more and more settlers arrive in North America, their need for natural resources grew. They killed wildlife, cut trees, and contaminated the water near their settlements. When the pressure on natural resources in a settled area grew too great, people moved westward into virgin forests and began the cycle again. Because the continent was so large, and populated only by scattered Native American tribes, settlers believed they could always move farther west to find more space and more

resources.

### The Conservation Movement

Early on, however, some settlers realized that the abundant natural resources of this new land were not limitless. In 1626, Plymouth Colony passed a law to control the cutting and sale of timber on colony lands. People in Newport, Rhode Island, agreed in 1639 to restrict deer hunting to six months a year. In Pennsylvania in 1681, William Penn decreed that one acre must be left forested for every five acres of forest that were cleared.

By the 1830's, people such as artist George Catalina and naturalist Henry David Thoreau were writing about the need to preserve some of the unique environments of North America in national parks. Yellowstone National park---America's first---was established in 1872.

People dedicated to environmental protection and wildlife conservation founded groups such as the Appalachian Mountain Club (1876), the New York Audubon Society (1886), the Sierra Club (1892), and the American Scenic and Historic Preservation Society (1895). Early in the 20th century, President Theodore Roosevelt, a hunter and fisherman, established national parks and forests and other federal agencies to protect natural resources and the environment.

### From Conservation to Environmentalism

In the early 1900's, people began to speak out about human activities that were causing serious environmental problems such as air and water pollution. As early as 1906, a scientific study by M.C. Marsh showed how fish were hurt by industrial wastes released into water sources. In 1962, Rachel Carson published *Silent Spring*, a book that discussed the dangers to the environment from using a pesticide known as DDT.

Carson and other people who wrote about the environmental effects of human activities helped to make the public aware of environmental concerns. This public awareness led to America's first "Earth Day," on April 22, 1970. Earth Day sparked an environmental movement in the United States. As a result, the U.S. Environmental Protection Agency (EPA), the Council on environmental Quality, and many state and local environmental agencies were established. Today, many laws protect our air, water, land, and wildlife resources.

### Boy Scouts and the Environment

In the early 1900's, as the conservation movement grew, two Americans started separate organizations for boys that focused on nature and the environment. Ernest Thompson Seton, was the official naturalist for the Canadian province of Manitoba. By 1902, he had moved to Connecticut, and founded a boy's club called Woodcraft Indians to preserve the wilderness knowledge of Native Americans. As a foremost naturalist of his time, Seton spoke before the U.S. congress in 1904 in support of legislation to protect migratory birds.

Daniel Carter Beard was a surveyor and engineer in Cincinnati, Ohio. he moved to New York, where he was an author, commercial artist, and illustrator. Beard wrote a book titled *The American Boy's Handy Book*. In 1905, he founded a boys' club called Sons of Daniel Boone to teach boys about nature, conservation, and outdoorsmanship.

On February 8, 1910, Seton and Beard merged their separate boys' clubs into the Boy Scouts of America. This new organization was founded by publisher William D. Boyce.

From its beginnings, the Boy Scouts of America had a strong foundation of woodcraft, nature study, and conservation. Many activities in Scouting come from activities of Native Americans. Many of the principles that Scouts uphold come from the conservation ethics of Seton and Beard. The BSA has taught more than 45 million young environmentalists throughout its history. Currently, with more than 1.5 million active members, the BSA continues to train the youth of America in principles of conservation and environmental science.

Two examples of poor management of the environment are the passenger pigeon and the buffalo.

As late as 1810, an ornithologist (a scientist who studies birds) named Alexander Wilson saw a flock of passenger pigeons one mile wide and 240 miles long. He estimated that the flock had more than 2 billion birds. In only a hundred years, the passenger pigeon was hunted to extinction. The last passenger pigeon died in the Cincinnati Zoo in 1914.

The artist George Catlin saw the enormous slaughter of bison on the prairies and wrote that if nothing was done to protect and preserve these animals, they would all be killed. His prediction nearly came true. American bison were hunted almost to extinction. From the millions of bison that once roamed the Great Plains, by 1884 only 300 were left. Fortunately this story turned out better than that of the passenger pigeon.

#### **DEFINITIONS:**

Ecology: Study of the interrelationships between organisms (living things) and their environment. Example: Where there are tall grasses, one would expect to see many insects which depend on the grasses for food and shelter. In turn one would expect to see birds and rodents which eat the insects.

Environment: Everything around an organism. Examples are sunlight, temperature, air, soil, minerals, water, and other living things. All of these elements work together to make life possible on earth.

Biosphere: The global ecosystem consisting of the seas, land, and fresh water. It contains all living things on earth and their environments, forming a thin film around the earth. It contains all of the requirements for life such as water, oxygen, and nutrients, which are endlessly recycled through the various ecosystems. It extends to the deepest part of the seas where life exists up to 370 feet over the land.

Ecosystem: Communities of plants and animals together with their physical environments make up an ecosystem. It consists of populations (groups of the same kind of plant or animal living together) and communities (all the populations of plants and animals in an area). An example is a deep woods and all of the plant and animal life it contains along with the physical environment --- the sunlight, air, water, soil, temperature, and other elements of the surrounding forest.

Plant Succession: The end of a series of changes which occur in an orderly pattern so that one type of plant is replaced over time by another and eventually the final community is reached. Several examples follow.

A farmer's field is allowed to lie fallow. Weeds and grasses grow during the first year. Some of these may have been in the soil and others are brought in by wind along with birds and animals. The second year longer lasting perennials appear. Soon shrubs and small trees appear which have been brought in by the wind (ash, maple, redbud, box elder) or birds and animals (various nut trees such as oaks and hickories, and fruits such as wild black cherries). Eventually these trees grow to a sufficient height that there is inadequate light for the tall grasses which disappear. The final community is one of tall trees.

A lake such as one of the great lakes gradually recedes from its shore line as it is filled in by sand. The beach at first has no land life, but as the water recedes still farther, some hearty plants which require little water appear. As these decay the soil is altered, so that other plants and trees are able to grow. Eventually a final community is reached which contains tall trees growing in a rich, moist soil.

A pond has soil gradually washed in by erosion from the surrounding land. Floating pond weeds may appear in the shallower water, followed by cattails and rushes. Eventually grasses and perhaps trees grow as the pond completely dries up.

The kind of final community that eventually will appear in an area is determined by the climate, geography, the kinds of plants and animals found in the area, types of soil, wind patterns, and other factors of the environment.

Carrying Capacity: The extent to which the environment supplies the basic needs of food, water, shelter, and living space determines the carrying capacity of the area. Thus any given area can only supply the needs of just so many animals. When the populations of animals grow larger than that area can support, the surplus animals

must leave or die. Different areas, depending on such environmental factors as soil, plant life, and climate are different in their abilities to support animal life. Humans can affect animal populations by what they do to the land, water, and plants.

**Limiting Factor:** The lack or shortage of food, water, cover, or living space becomes a limiting factor because it limits the kinds and numbers of animals that can live in an area. If a population were not subject to any limiting factors, it could grow very large. For instance, a pair of houseflies that started breeding in April could have 191 quintillion (191,000,000,000,000,000,000) offspring by August if all their eggs hatched and if all the young flies lived to reproduce. However, a shortage of any one of the four basic needs (water, food, shelter, living space) limits the size to which such a population can grow and prevents runaway increases like that. The smaller forms of life on earth are the most numerous, as they supply food for larger animals.

Generally, animals that mainly eat plants produce many more young than the environment could support for long, and this apparent overproduction is the source of food for the next group of animals in the food chain. There are, for instance, many more mice than foxes in any natural community where both live. The foxes eat the “extra” mice, so the overall population of the smaller animals usually is not affected. Thus the predators, or carnivores, have a steady supply of food, and they help to keep the herbivores, or plant-eaters, within the limits of a community’s carrying capacity for those animals.

**Food Chain:** The path of energy through a community of plants and animals is called a food chain. The chain begins with the green plants that are producers for the community, changing carbon dioxide, water, and minerals into food, and releasing oxygen. Every food chain ends with the decomposers, the bacteria, fungi, and certain insects. Plants may die and be broken down by the decomposers directly, or plants may be eaten by herbivores, which are primary consumers which may die and decompose, or they may be eaten by carnivores which then die and decompose.

### **Plants:**

Grasses and other green plants are the basic sources of food in the environment. Many animals depend on plants for food, because green plants do something animals cannot do. They are like factories, able to make food from raw materials they take out of the air, water, and soil. Chlorophyll enables plants to use the energy from sunlight to manufacture sugars and starches from water and from carbon dioxide found in the air by a process called photosynthesis. During photosynthesis, plants give off oxygen, which is necessary to the life of all air-breathing animals on earth. It takes a patch of grass 25 square feet to produce enough oxygen to meet the needs of one adult human. An acre of healthy young woodland can keep 18 people alive. Thus, the presence of plants and trees are very important to us, which leads to the concerns about destroying the rain forests. In addition to their important functions of manufacturing food, removing carbon dioxide from the air and supplying oxygen, plants also do many other things such as breaking down dead plants and animals into simple elements that can then be reused by higher plants and taking nitrogen from the atmosphere and “fixing” it for use as fertilizer. Plants also are important to prevent erosion.

### **Animals:**

There is almost no environment in which animals are not found. Animals are classified as invertebrates (animals without a backbone) such as sponges, jellyfish, worms, mollusks, spiders, crabs, and insects, and vertebrates (animals with a spine) such as fish, frogs, reptiles, birds, and mammals. Animals are also classified according to what they eat. Herbivores eat only plants, carnivores eat only meat, and omnivores eat both plants and animals.

### **Sunlight:**

Sunlight is essential not only for photosynthesis, but also to provide energy to evaporate water into the atmosphere, and to warm the earth.

### **Air:**

The air, or atmosphere, is a fragile layer surrounding the earth that shields and

protects the planet. It shelters us from the fierce heat and cold of space. It carries moisture and many microscopic particles that filter out the damaging rays of sunlight. It draws up water and distributes it over the planet's surface. Without air, there would be no sound. Air is also a part of the soil, and is needed for plant root growth and needed by the millions of tiny organisms that live in the soil.

### **Soil:**

There are many kinds of soils. Most soils have a layer of decaying plant material on top. The next layer, or topsoil, usually contains large amounts of decaying vegetation and plant roots, is dark in color and contains a lot of air in the pores between soil particles. Beneath the topsoil is a layer of subsoil which has fewer plant roots growing in it and is lighter in color. Beneath the subsoil are layers of rock, which are broken down by weathering into soil particles. Most soils are made up of mineral particles, organic (plant and animal) matter, water, dissolved chemical compounds, and air. Some soils are mostly made up of gravel and rock fragments, some are sandy, some are finer in texture and contain a lot of very small particles called silt and clay. Sandy soils have many air-filled spaces, but water drains through it very quickly, so plants find it difficult to get sufficient water to grow in it. Soils with a great deal of clay hold water so tightly that the air spaces become filled with water, and few plants can grow in such waterlogged soils. Most plants grow best in loams, which have fairly large amounts of each size of particle, including clay, silt, fine sand, and coarse sand along with a lot of organic matter, mostly decaying vegetation. The organic matter increases the amount of water soil can hold and also supplies food for the tiny soil plants and animals.

### **Water:**

Water is the essential ingredient of life on earth. Plants must have water to live. Plant seeds need moisture to germinate. Plant roots absorb water, which carries minerals and chemical compounds from the soil to the plant's stems and leaves. Plants give off much of the water they absorb into the atmosphere by a process called transpiration. Water is also essential to all animals. Water makes up 65 to 70% of the human body.

### **Cycles:**

Plants, animals, sunlight, air, soil, and water are linked together in endless natural cycles through which materials are reused again and again.

Carbon Cycle: Green plants get carbon from carbon dioxide in the air and, through photosynthesis, use it to make sugars and starches. Herbivores eat the plants along with their stored carbon. Carnivores may eat the herbivores, and then the carbon passes into their bodies. Eventually, plants and animals die and other organisms, called decomposers, break down the bodies and release the carbon back into the atmosphere, where it is once again available for plants to use.

Water Cycle: Water is taken in by plants and animals. Plants give off much of this water back into the atmosphere by transpiration. Water from transpiration and evaporation from streams, rivers, lakes, ponds, and oceans goes into the atmosphere where it falls back to earth as rain or snow. This water is absorbed into the ground, runs off into streams and rivers, or percolates through the soil and becomes ground water.

Nitrogen Cycle: Decay of plants, animals and manure produces ammonia which is converted by bacteria in the soil to nitrites and then to nitrates which can be incorporated by the plant into its stored nutrients. Some plants can also utilize nitrogen from the air. This plant nitrogen is then consumed by herbivores and perhaps subsequently by carnivores.

Interruption of Natural Cycles: The natural cycles can be disrupted through the addition of sewage or other foreign materials to the water. Minerals and chemicals in sewage or runoff from farmlands can add greatly to the richness or productivity of the water, and cause plants such as algae to grow rapidly and densely. As the layer of algae grows thicker, sunlight can't reach as far below the surface of the lake, and the lower layers of algae may die. Oxygen is used up in the process of the decay, and

as the dead algae decays so much oxygen may be used up that there won't be enough left for the fish. Without oxygen the fish will die, all because a foreign substance upset the lake's natural cycles. DDT, now banned, was once among the most common pesticides, widely used to kill flies, mosquitoes, caterpillars, and other annoying or destructive insects. However DDT washed into water sources where it was absorbed by the tiny plants and animals which serve as food for larger animals. Thus DDT was passed right up the food chain. DDT may interfere with reproduction. Thus, we need to think carefully about the possible long-term consequences of substances which we introduce into nature.

### **Needs of Animals:**

All animals need water, food, shelter, and living space. Some require only very small amounts of space, while others roam for miles.

### **Pollution**

Water Pollution: Water pollution is the addition of foreign materials, chemicals, compounds or any substances that reduce water's cleanliness or purity or adversely alters its relationship with other elements of the ecosystem. One other kind of water pollution involves the addition of heat instead of harmful compounds. This is called thermal pollution. There is a certain amount of natural erosion which is not a source of pollution. However, farming methods may speed up this natural process. Sewage and other organic wastes may transmit diseases or may use up oxygen as they decompose, making the water unsuitable for aquatic life. Toxic wastes and chemical pollutants including those from fertilizers are another form of water pollution. Pesticides cause water pollution. Heat can interfere with the life processes of aquatic plants and animals. This problem can be eliminated through the use of cooling towers and other methods of cooling the water before it is released into rivers or lakes.

Land Pollution: Besides forcing the use of wilderness and farmlands for housing and industrial uses, our growing population has made it necessary also to dig into the earth in search of minerals and oil. Land is being used more and more for the disposal of municipal and industrial wastes. Litter is a common kind of land pollution. To control erosion, many American farmers have changed from ordinary plowing methods to minimum tillage practices that can stop soil losses. Conservation of fuel supplies and a gradual growth in alternative energy sources such as solar energy and wind power are making us less dependent on fossil fuels. New ways of disposing of hazardous wastes are being developed. Some toxic wastes contain ingredients that can be recovered and reused. Many can be destroyed by burning at very high temperatures. Litter is something all of us can readily control.

Air Pollution: About 95% of the earth's atmosphere is contained in a layer only 7 miles deep. Tons of dust and ash pour out of smokestacks and from the exhausts pipes of automobiles. Burning of coal and oil adds carbon dioxide and water to the air, which are perfectly harmless, but sulfur dioxide and other materials produce acid rain which damages many materials as well as causing damage to the lungs. Ozone is produced by automobile exhausts, power plants, and many industrial processes. Acid Rain is produced when sulfur dioxide, nitrogen dioxide, and ozone are combined with water vapor in the presence of sunlight to produce powerful acids such as sulfuric acid, nitric acid, and hydrogen peroxide. Air pollution can be solved if we are willing to pay for it.

Chemical Pollution: Chemical pollution is the result of chemicals such as DDT, PCB's and mercury. Mercury is produced by some plastics factories. The mercury was first released in a nondissolving and nontoxic form that no one thought would hurt anything. When it settled to the bottom mud of the lake, however, tiny organisms changed it into a compound (methyl-mercury) that could dissolve in water and accumulate in organisms. This poison was thus passed up the food chain and has caused mercury poisoning in humans. PCB's are utilized in electrical transformers and have been an important source of long-term chemical pollution.

**DEFINITIONS:** (Requirement 2)

Ecology: Study of the interrelationships between organisms (living things) and their environment. Example: Where there are tall grasses, one would expect to see many insects which depend on the grasses for food and shelter. In turn one one expect to see birds and rodents which eat the insects.

Environment: Everything around an organism. Examples are sunlight, temperature, air, soil, minerals, water, and other living things. All of these elements work together to make life possible on earth.

Biosphere: All parts of the earth where life exists. The global ecosystem consists of the seas, land, air, and fresh water. It contains all living things on earth and their environments, forming a thin film around the earth. It contains all of the requirements for life such as water, oxygen, and nutrients, which are endlessly recycled through the various ecosystems. It extends to the deepest part of the seas where life exists up to 370 feet over the land.

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Organism: A living thing---an individual capable of carrying on the activities of life. All living things have the ability to make more of the same kind of living thing--they can reproduce. Living things also change during their lifetimes. They grow and develop, and have a life span than eventually ends in death. Another important characteristic of living things is that they can usually adjust to their surroundings. They can respond to changes in their environments.

Relationships Within Ecosystems: Within an ecosystem such as a Florida river, the actions of every species affect other species, populations, and communities. A rat snake feeds on small rodents, keeping the rodent population small enough that they don't eat all of the plant seeds available. An alligator stirs up bottom mud, releasing worms and organic matter that other organisms use for food. Both rat snakes and alligators help to maintain their ecosystems.

Niches and Habitats: A niche is the way in which a particular species or individual organism fits in a community, including the way it feeds, the space it takes up, how it reproduces, and how it interacts with nonliving factors. A habitat is the physical place where an organism lives out its life. How is your own community maintained? You might live in a community where the trash is picked up once or twice a week. In the summertime, perhaps you mow your neighbor's lawn once a week. Maybe your cat keeps your house free of mice. The trash collectors, you , and your cat all have roles to play in your community.

A niche is the role of a species in its community. The niche of fungi, for example, is not simply to get nutrients (food) from dead or dying trees, but also to release those nutrients back into the environment in a form that other organisms can use.

Besides having a role within a community, organisms occupy space. You life in a house, an apartment, or some other type of shelter. Great blue herons roost high in trees along riverbanks. Common snapping turtles burrow into the mud at the bottom of a river. The place in which an organism lives is its habitat. The habitat of a gar, for example, is the river itself.

Within any habitat, the food, shelter, and other resources are divided into separate niches. For example, a Florida river is a habitat for both red-bellied turtles and bullfrogs. Adult turtles eat only water plants. Bullfrogs eat insects, snails, fish, and frogs. Because these two species eat different foods, they occupy different niches within the same habitat.

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of the air, water, and soil. Chlorophyll enables plants to use the energy from sunlight to manufacture sugars and starches from water and from carbon dioxide found in the air by a process called photosynthesis. During photosynthesis, plants give off oxygen, which is necessary to the life of all air-breathing animals on earth. It takes a patch of grass 25 square feet to produce enough oxygen to meet the needs of one adult human. An acre of healthy young woodland can keep 18 people alive. Thus, the presence of plants and trees are very important to us, which leads to the concerns about destroying the rain forests. In addition to their important functions of manufacturing food, removing carbon dioxide from the air and supplying oxygen, plants also do many other things such as breaking down dead plants and animals into simple elements that can then be reused by higher plants and taking nitrogen from the atmosphere and “fixing” it for use as fertilizer. Plants also are important to prevent erosion.

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#### **Sunlight:**

Sunlight is essential not only for photosynthesis, but also to provide energy to evaporate water into the atmosphere, and to warm the earth. Nearly all living things depend upon the sun for energy, either directly or indirectly. Plants, algae, and other organisms “trap” sunlight and capture its energy to power their life processes, or they store it. When a snail eats a plant, for example, the snail uses the stored energy in the plant to power its own life processes. When a raccoon eats the snail, the energy is passed along. Green plants, algae, and other photosynthetic organisms must live where there is sunlight. In watery environments, photosynthetic organisms can live only in the top layer of the water, where sunlight reaches.

#### **Temperature:**

In general, the temperature of an environment depends on the amount of sunlight it gets. Air is heated more at the equator than at the poles. This is why tropical areas near the equator are hot, the polar regions are cold, and the regions in between have moderate temperatures. Temperatures are also affected by earth’s rotation, by winds and ocean currents created by that rotation, by the tilt of the earth on its axis, and by elevation. As you hike up a mountain, the air temperature drops. That is why it is possible to have a snowball fight on top of Mount Baldy at Philmont Scout Ranch in New Mexico in July!

#### **Air:**

The air, or atmosphere, is a fragile layer surrounding the earth that shields and protects the planet. It shelters us from the fierce heat and cold of space. It carries moisture and many microscopic particles that filter out the damaging rays of sunlight. It draws up water and distributes it over the planet’s surface. Without air, there would be no sound. Air is also a part of the soil, and is needed for plant root growth and needed by the millions of tiny organisms that live in the soil.

#### **Soil:**

There are many kinds of soils. Most soils have a layer of decaying plant material on top. The next layer, or topsoil, usually contains large amounts of decaying vegetation and plant roots, is dark in color and contains a lot of air in the pores between soil particles. Beneath the topsoil is a layer of subsoil which has fewer plant roots growing in it and is lighter in color. Beneath the subsoil are layers of rock, which are broken down by weathering into soil particles. Most soils are made up of mineral particles, organic (plant and animal) matter, water, dissolved chemical compounds, and air. Some soils are mostly made up of gravel and rock fragments, some are sandy, some are finer in texture and contain a lot of very small particles called silt and clay.

Sandy soils have many air-filled spaces, but water drains through it very quickly, so plants find it difficult to get sufficient water to grow in it. Soils with a great deal of clay hold water so tightly that the air spaces become filled with water, and few plants can grow in such waterlogged soils. Most plants grow best in loams, which have fairly large amounts of each size of particle, including clay, silt, fine sand, and coarse sand along with a lot of organic matter, mostly decaying vegetation. The organic matter increases the amount of water soil can hold and also supplies food for the tiny soil plants and animals.

### **Water:**

Water is the essential ingredient of life on earth. Plants must have water to live. Plant seeds need moisture to germinate. Plant roots absorb water, which carries minerals and chemical compounds from the soil to the plant's stems and leaves. Plants give off much of the water they absorb into the atmosphere by a process called transpiration. Water is also essential to all animals. Water makes up 65 to 70% of the human body.

### **Cycles:**

Plants, animals, sunlight, air, soil, and water are linked together in endless natural cycles through which materials are reused again and again.

Carbon Cycle: Green plants get carbon from carbon dioxide in the air and, through photosynthesis, use it to make sugars and starches. Herbivores eat the plants along with their stored carbon. Carnivores may eat the herbivores, and then the carbon passes into their bodies. Eventually, plants and animals die and other organisms, called decomposers, break down the bodies and release the carbon back into the atmosphere, where it is once again available for plants to use.

Water Cycle: Water is taken in by plants and animals. Plants give off much of this water back into the atmosphere by transpiration. Water from transpiration and evaporation from streams, rivers, lakes, ponds, and oceans goes into the atmosphere where it falls back to earth as rain or snow. This water is absorbed into the ground, runs off into streams and rivers, or percolates through the soil and becomes ground water.

Nitrogen Cycle: Decay of plants, animals and manure produces ammonia which is converted by bacteria in the soil to nitrites and then to nitrates which can be incorporated by the plant into its stored nutrients. Some plants can also utilize nitrogen from the air. This plant nitrogen is then consumed by herbivores and perhaps subsequently by carnivores.

Interruption of Natural Cycles: The natural cycles can be disrupted through the addition of sewage or other foreign materials to the water. Minerals and chemicals in sewage or runoff from farmlands can add greatly to the richness or productivity of the water, and cause plants such as algae to grow rapidly and densely. As the layer of algae grows thicker, sunlight can't reach as far below the surface of the lake, and the lower layers of algae may die. Oxygen is used up in the process of the decay, and as the dead algae decays so much oxygen may be used up that there won't be enough left for the fish. Without oxygen the fish will die, all because a foreign substance upset the lake's natural cycles. DDT, now banned, was once among the most common pesticides, widely used to kill flies, mosquitoes, caterpillars, and other annoying or destructive insects. However DDT washed into water sources where it was absorbed by the tiny plants and animals which serve as food for larger animals. Thus DDT was passed right up the food chain. DDT may interfere with reproduction. Thus, we need to think carefully about the possible long-term consequences of substances which we introduce into nature.

### **Needs of Animals:**

All animals need water, food, shelter, and living space. Some require only very small amounts of space, while others roam for miles.

### **Interactions Among Living Things:**

Think again of the organisms living in a Florida river. There are several different *species* of turtles living there. A species is a group of organisms that can

produce fertile offspring. That is, raccoons are a species because they can mate and have baby raccoons that will grow up to produce other raccoons. In the river, there are at least three species of turtles---red-bellied turtles, cooters, and common snapping turtles. All of the individual red-bellied turtles living in the river make up a *population* of red -bellied turtles. All of the cooters make up a population of cooters, and all of the snapping turtles make up a population of snapping turtles. You can see that the river environment contains many different populations of organisms.

Populations of organisms, of course, don't live alone in the environment. Most interact with other populations in a given area. The red-bellied turtles interact with (they eat) the eel grass. The eel grass provides hiding places for young fish and tadpoles. The great blue herons eat the bullfrogs. Populations are constantly changing in size, density, and age as they respond to changes in their environment. If the herons eat all of the adult bullfrogs in the river, for example, the population of bullfrogs will include only tadpoles and eggs.

Groups of populations that interact with one another in a given area form a *community*. All of the populations in a community depend upon one another for needs such as food and shelter. The populations of organisms that live together and interact with one another---such as herons, alligators, bullfrogs, insects, and turtles ---form the Florida river's living community. The river, the soil along the bank, the rocks in the river, and the sun shining on the river are some of the nonliving factors in the environment.

The living community of the river, and the nonliving factors that affect it, form relationships that together make up an *ecosystem*. Ecosystems, such as a river, pond, forest, or desert, may be treated as separate parts of the environment.

### **Feeding Relationships:**

Many of the relationships within a community are feeding relationships. That is because most animals must eat to get the energy they need for life. Almost all of the energy on earth begins with the sun. Green plants, algae, and other organisms that trap the sun's energy in the process of photosynthesis are called producers. Producers are organisms such as green plants that make food from carbon dioxide and water, using the sun's energy. Through photosynthesis, they make the sun's energy available to other organisms. All other organisms depend upon producers for energy.

Some organisms get the energy they need by eating plants and other producers. Mice and rats, for example get their energy by eating the seeds of plants. Others living things get energy by eating organisms that eat plants. Rat snakes, for example, eat the mice and rats that eat plant seeds. Organisms such as mice, rats, and rat snakes are called consumers. Consumers are organisms that cannot make their own food; they must eat other organisms to get energy. Your house plant and the trees in the park are producers. You and your pet cat or dog are consumers.

Decomposers break down dead organisms and absorb energy and nutrients from them. Bacteria and most fungi are decomposers. When they break down the bodies of dead organisms, they use some of the energy and nutrients for their own life processes, but also return energy and nutrients to the soil as organic matter. Think what the world would be like without decomposers?

"Producer," "consumer," and "decomposer" are terms ecologist use for different niches within an ecosystem. These roles are important for an ecosystem to function. Ecologist further divide these niches into feeding relationships. you probably are already familiar with a feeding relationship known as the predator-prey relationship. Rat snakes, herons, alligators, and frogs are all predators that eat prey. Other feeding relationships include parasite-host relationships, such as a mosquito (the parasite) feeding upon your blood (you're the host).

There are many other types of relationships within an ecosystem. Feeding relationships are one type of *symbiosis*. Symbiosis is a term that means "living together." Sometimes, organisms of different species live together but do not feed

upon each other. Some fish live among the stinging tentacles of sea anemones, but the anemones don't harm them. These fish have a symbiotic relationship with sea anemones in which the fish do not affect the anemones one way or the other, but the anemones protect the fish.

### **Energy Flow in Ecosystems:**

Energy flows continuously through an ecosystem. When a red-bellied turtle eats eel grass, it consumes energy the grass produced from trapped sunlight. When the turtle dies, decomposers make the energy in its body available again to other organisms.

A *food chain* shows how energy moves through an ecosystem. In a Florida river, one food chain might include eel grass, a red-bellied turtle, and a great blue heron. Food chain may have only two links---a producer and one consumer, for example. Most move no more than five links. Only a part of the energy that a producer traps is available for the first consumer, because the producer uses some of that energy for its own life processes. In the same way, only a portion of the energy eaten by the first consumer is available for the next consumer, and so on. By the fifth link in a food chain, very little energy is left from the original producer.

There are many individual food chains in any one ecosystem. Great blue herons, raccoons, and alligators are parts of many food chains because they eat many kinds of foods. To try to understand the interactions within ecosystems, ecologists use a model called a food web that shows many interconnected food chains. A food web is a model that shows all of the feeding relationships in an ecosystem. It usually appears as a network of connected food chains. Food webs describe an ecosystem in a more realistic way than food chains because most organisms depend upon more than once source of food.

### **Human Impact on the Biosphere:**

Think about the things you do every morning to get ready for school. You wake up as the sun filters through the window. Maybe you wash your face and brush your teeth, or take a shower. Perhaps you have a bowl of cereal and milk for breakfast.

Do you realize that you use natural resources every morning? The sun's energy is a natural resource. The water for your shower, the cotton plant that provides fibers for your clothes, the grain that's processed into cereal, and the milk you poured into your bowl are all natural resources.

### **What Are Resources?**

Natural resources are all of the living and nonliving factors in the biosphere, including nutrients, minerals, soil, water, organisms, and other resources made by natural processes on earth. They are the materials that you and all living things use every day.

### **Renewable Resources:**

Some natural resources can be used over and over. The water you used for your shower, the grain that became your cereal, and the cotton in your clothes all represent *renewable resources* because they can be replaced by natural processes. All organisms, including cotton and grain plants, are renewable because they can reproduce. Both water and carbon, as you know, are cycled through the biosphere, so they are renewable. The sun is a renewable resource because it continuously provides energy to earth. Even soil fertility is renewable because natural processes can replace nutrients in soil.

### **Nonrenewable Resources:**

What did you have for lunch today? Maybe you have a drink from an aluminum can, or bought a hamburger packaged in a plastic foam box and a plastic bag. Perhaps you rode home on a bus. The aluminum, polystyrene foam, plastic bag, and the gasoline that powered the bus are examples of *nonrenewable resources*---they are available in only limited amounts and are not replaced or recycled by natural processes. Metals such as aluminum, tin, copper, iron, and gold are nonrenewable resources taken from the earth's crust. Plastic bags, plastic foam, and

gasoline are all petroleum products made from oil, another nonrenewable resource.

Some resources, such as phosphorus, are replaced so slowly by natural processes that they can be thought of as nonrenewable. Topsoil (the most fertile layer of soil) is an example of a resource that is renewable by natural processes such as weathering, but it takes so long that we think of topsoil as nonrenewable. It may take natural processes between 500 and 1,000 years to form one inch of topsoil.

#### **Problems with Resource Use:**

All organisms produce *waste products*. During photosynthesis, plants take in carbon dioxide and give off oxygen as a waste product. You breathe in oxygen and breathe out carbon dioxide as a waste product. When you eat a hard-boiled egg or an orange, you throw away the eggshell or orange peel. Decomposers in the soil can break down eggshells and orange peels into the nutrients plants need. Orange peels, eggshells, oxygen, and carbon dioxide are all waste products, but also natural resources that can be recycled in the biosphere by natural processes.

What happens when waste products are produced too quickly, or in amounts too great to be recycled naturally? When waste products build up faster than they can be broken down, they become *pollutants*.

#### **Pollution:**

Water Pollution: Water pollution is the addition of foreign materials, chemicals, compounds or any substances that reduce water's cleanliness or purity or adversely alters its relationship with other elements of the ecosystem. One other kind of water pollution involves the addition of heat instead of harmful compounds. This is called Thermal pollution. There is a certain amount of natural erosion which is not a source of pollution. However, farming methods may speed up this natural process. Sewage and other organic wastes may transmit diseases or may use up oxygen as they decompose, making the water unsuitable for aquatic life. Toxic wastes and chemical pollutants including those from fertilizers are another form of water pollution. Pesticides cause water pollution. Heat can interfere with the life processes of aquatic plants and animals. This problem can be eliminated through the use of cooling towers and other methods of cooling the water before it is released into rivers or lakes.

Land Pollution: Besides forcing the use of wilderness and farmlands for housing and industrial uses, our growing population has made it necessary also to dig into the earth in search of minerals and oil. Land is being used more and more for the disposal of municipal and industrial wastes. Litter is a common kind of land pollution. To control erosion, many American farmers have changed from ordinary plowing methods to minimum tillage practices that can stop soil losses. Conservation of fuel supplies and a gradual growth in alternative energy sources such as solar energy and wind power are making us less dependent on fossil fuels. New ways of disposing of hazardous wastes are being developed. Some toxic wastes contain ingredients that can be recovered and reused. Many can be destroyed by burning at very high temperatures. Litter is something all of us can readily control.

Air Pollution: About 95% of the earth's atmosphere is contained in a layer only 7 miles deep. Tons of dust and ash pour out of smokestacks and from the exhausts pipes of automobiles. Burning of coal and oil adds carbon dioxide and water to the air, which are perfectly harmless, but sulfur dioxide and other materials produce acid rain which damages many materials as well as causing damage to the lungs. Ozone is produced by automobile exhausts, power plants, and many industrial processes. Acid Rain is produced when sulfur dioxide, nitrogen dioxide, and ozone are combined with water vapor in the presence of sunlight to produce powerful acids such as sulfuric acid, nitric acid, and hydrogen peroxide. Air pollution can be solved if we are willing to pay for it.

Chemical Pollution: Chemical pollution is the result of chemicals such as DDT, PCB's and mercury. Mercury is produced by some plastics factories. The mercury was first released in a nondissolving and nontoxic form that no one thought would hurt anything. When it settled to the bottom mud of the lake, however, tiny organisms

changed it into a compound (methyl-mercury) that could dissolve in water and accumulate in organisms. This poison was thus passed up the food chain and has caused mercury poisoning in humans. PCB's are utilized in electrical transformers and have been an important source of long-term chemical pollution.

### **The Ozone Layer:**

In the stratosphere, when oxygen interacts with lightning and ultraviolet radiation from the sun, a gas called *ozone* forms. Ozone is constantly made and destroyed in the stratosphere, but usually the amount of ozone in this layer remains constant. Ozone is important because it prevents harmful ultraviolet radiation from reaching earth's surface. Ultraviolet (UV) radiation harms humans and other animals by damaging the skin, eyes, and immune system. UV rays also hurt plants and aquatic organisms.

### **The Greenhouse Effect:**

Carbon dioxide, water vapor, and small amounts of ozone, methane, and other gases in the atmosphere help to regulate the earth's temperatures and thus its climate. These gases act like the panes of glass in a greenhouse. They let sunlight through to warm the earth's surfaces. Some of this heat rises. In the troposphere, the heat may be absorbed by the greenhouse gases, warming the air, or it may be radiated back to the surface. Some heat may be lost to space. This *greenhouse effect* warms the earth's surface, allowing life to exist. Without the greenhouse gases, much of the sun's energy would be lost to space.

### **Acid Rain:**

When fossil fuels burn, they produce carbon monoxide, nitrogen oxides, sulfur oxides, and hydrocarbons. Burning fossil fuels releases these gases into the atmosphere, where they directly affect the air or interact with other gases to form new compounds that are also air pollutants. For instance, when carbon dioxide is released in the atmosphere, it dissolves in water drops, forming a weak acid called *carbonic acid*. Because of carbonic acid in the atmosphere, most rain is slightly acidic.

Acidity is measured on a scale, called the pH scale, of 0 to 14, with 7 being neutral. If a substance has a pH below 7, it is an acid. Water has a pH of 7, but ordinary rainwater has a pH of about 5.6 because of the weak carbonic acid dissolved in raindrops.

When vehicles and power plants emit sulfur dioxide and nitrogen oxides into the air, these gases interact with water vapor to form strong acids. These acids then fall to the earth's surface as *acid rain* (sometimes called *acid precipitation*, because it can be in the form of snow, mist, or fog). Acid rain is any rain or other type of precipitation with a pH below 5.6.

Plants may die from acid rain directly, or be weakened so that they are more easily hurt by other kinds of stresses in the environment, such as cold temperatures, insect damage, or droughts. Acid rain damages aquatic ecosystems by changing the pH of the water. Many aquatic organisms die when acid rain falls into lakes and ponds. Acid rain also damages buildings by dissolving the rock they are made of.

Acid rain is a worldwide problem because the gases that make it may be produced in one state or country and be blown to another state or country by winds. More than half of the acid rain that falls in southeastern Canada and the northeastern United States begins with the coal- and oil-burning plants of Ohio, Indiana, Pennsylvania, Illinois, Missouri, West Virginia, and Tennessee.

### **Global Warming:**

Over the last 40 years or so, human activities have released more and more greenhouse gases---particularly carbon dioxide, methane, and nitrous oxide---into the atmosphere.

- Carbon dioxide is released in large amounts by burning fossil fuels, especially coal, and by clearing land and burning forests.
- Cattle, sheep, termites, and the breakdown of organic matter by bacteria produce methane. Methane traps about 25 times as much heat as does carbon dioxide.

- Nitrous oxide is produced when forests are cleared by burning, when coal burns, and when nitrogen fertilizers break down in soil. Nitrous oxide traps about 230 times as much heat as does carbon dioxide.

All of these greenhouse gases have increased in the atmosphere because of human activities. Since these gases trap more heat than normal levels of greenhouse gases, some scientists think the gases cause *global warming*. Scientists who study global climate trends have records which show that the average temperature on earth has risen 0.7° to 1.3°F in the last 100 years. They are worried that rising temperatures due to global warming will have disastrous effects on all of the earth's ecosystems.

A rapid change in the earth's climate would change the environment faster than most species could adapt. Global warming could melt the polar ice caps, raise sea levels, and flood coastal cities and islands. It also could change the places where people can grow food. However, even though many scientists agree that global warming may be happening, they disagree about the damage that this warming might do.

#### **DDT in the Food Chain:**

DDT caused problems that got worse as it moved through the food chain. Suppose a small fish ate plankton (tiny water organisms) laced with DDT. A bigger fish ate many of the small fish; the DDT that was in all of the small fish became concentrated in the tissues of the larger fish. When a bald eagle or a peregrine falcon ate several large fish, the birds ended up with a lot of DDT in their bodies. The DDT caused the birds to lay eggs with thin shells. The eggshells were so fragile that they would break before the eggs hatched, killing the chicks. Birds harmed in this way by DDT included the osprey, cormorant, bald eagle, brown pelican, peregrine falcon, sparrow hawk, and prairie falcon. DDT's effect on birds first came to the public's notice when Rachel Carson published her book *Silent Spring* in 1962.

#### **The Exxon Valdez:**

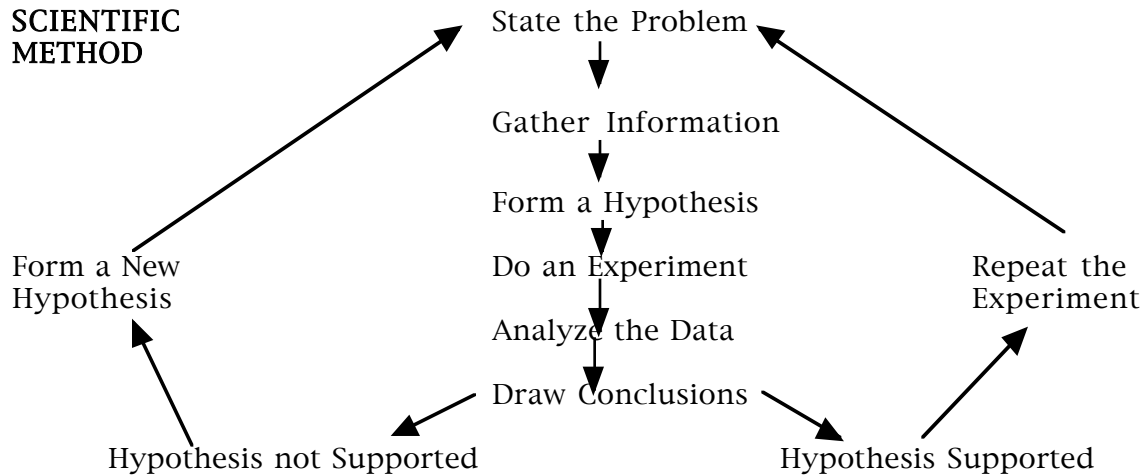
In 1989, an oil tanker called the **Exxon Valdez** struck Bligh Reef, spilling its cargo of crude oil into Alaska's Prince William Sound. The 11 million gallons of spilled oil coated more than 1,000 miles of shoreline, killing at least 300,000 birds, 5,000 sea otters, 300 harbor seals, 2 whales, and countless numbers of fish and other aquatic organisms. Because most of the dead animals sank, no one knows the full effect of this devastating oil spill.

#### **Methods of Oil Spill Cleanup:**

- **Bioremediation** uses fertilizers to increase the population of oil-eating microbes. This process is very harmful to humans and animals in the first 24 hours after application. If animals cannot be restricted from the cleanup area, bioremediation probably can't be used.
- **Boom** is a floating barrier used to contain and absorb an oil spill; its high-maintenance requirements can sometimes outweigh its effectiveness.
- **Burning** reduces large amounts of oil to a tarry residue. It requires favorable weather conditions and must be done within 72 hours after the spill occurs.
- **Chemical dispersants** help "scatter" oil into larger volumes of water and help prevent oil from reaching shorelines. Dispersants must be "mixed" with oil, which requires good wave action.
- **Hot-water washing** works best on heavily oiled beaches, but it "cooks" all plant life and animal life in its path, leaving beaches sterile.
- **Skimmers** collect oil from the water's surface. Under the right conditions, skimmers serve as one of the most environmentally sound forms of oil collection. However, like boom, this equipment is difficult to maintain.

# Experiments:

## SCIENTIFIC METHOD



### 3a Ecology

#### (1) How Does the Environment Affect Living Things?

You have learned that the nonliving parts of the environment have important effects on living things. In this experiment, you will learn how light affects earthworms.

##### **Materials:**

Cardboard shoe box with lid	Scissors
10 earthworms (or meal worms)	Notebook
Lamp with 100-watt light bulb	Pen or pencil

##### **Procedures:**

1. Cut the shoe box lid in half. Put half of the lid on the shoe box so that it shades one side of the box.
2. Place the lamp next to the middle of the shoe box, close enough that it shines on the uncovered part of the box.
3. Place 10 earthworms (meal worms) on the centerline of the bottom of the shoe box so that the worms are half in the dark and half in the light.
4. Observe the worms for 5 minutes. Note their behavior in your notebook.
5. When you experiment is over, take the worms outside and return them to the soil.

##### **Observations:**

1. What did the worms do at the beginning of the experiment?
2. How much time did the worms spend in the lighted part of the shoe box? In the shaded part of the shoe box?
3. What nonliving environmental factor does the lamp represent?

##### **Conclusions:**

An organism's response to light is called phototropism. An organism that responds to light by moving toward it is said to be positively phototropic. An organism that moves away from light is negatively phototropic. Which type of response did your worms show? Why would earthworms react this way to light?

### 3b Air Pollution

- (2) **Acid Rain.** Sulfur oxides and nitrogen oxides are chemicals that react with water vapor in the air to form sulfuric acid and nitric acid. Rain containing these acids falls on plants and bodies of water. In this experiment, you can find out how acid rain affects land plants.

##### **Materials:**

Five small potted plants of the same species and size  
Distilled water (pH 7)  
Five small spray bottles  
White vinegar (pH 2)  
Magnifying glass

Safety goggles  
Apron  
Ruler  
Set of measuring cups  
Labels and marking pen

**Procedures:**

1. Use the labels and marking pen to number the plants 1,2,3,4, and 5.
2. Measure the height of each plant, and record the heights in your notebook. Count the number of leaves on each plant and record these data as well.
3. Use a magnifying glass to examine each plant. Draw each plant in your notebook and color in any areas that show damage.
4. For the rest of this activity, put on goggles and an apron to protect your eyes and clothing. Use a measuring cup to pour 1 cup of distilled water into each of four spray bottles. Mark these as bottles 1,2,3, and 4.
5. Use a measuring cup to pour 1 cup of vinegar into another spray bottle. Mark this as bottle 5. This bottle, containing undiluted vinegar, has a pH of 2.
6. Measure 2 teaspoons of vinegar and pour into bottle 2. This bottle now has a pH of approximately 5.
7. Measure 3 teaspoons of vinegar and add to bottle 3. This bottle now has a pH of approximately 4.
8. Measure 4 teaspoons of vinegar and add to bottle 4. This bottle now has a pH of approximately 3. Bottle 1, containing distilled water only, has a pH of 7.
9. Place all five plants in a sunny location. Water each one with the same amount of tap water. Do not overwater the plants.
10. Spray plant 1 with bottle 1, plant 2 with bottle 2, plant 3 with bottle 3, plant 4 with bottle 4, and plant 5 with bottle 5. Make sure you spray the soil in each pot, because plants absorb water through their roots, not through their leaves. Use the same number of sprays on each plant each time.
11. Wait one day and examine each plant with a magnifying glass. Measure the height of each plant and count the number of leaves. Record these data in your notebook.
12. Repeat steps 10 and 11 every day for five days.

**Observations:**

1. Did you see any changes in the leaves of plant 1 during the experiment? In plants 2, 3, 4, or 5?
2. If you saw changes, what kinds of changes did you see?
3. Normal rainwater has a pH of about 5.6. Did any of the plants in the experiment receive treatment that compared to normal rain?
4. Explain why you drew a picture of the damaged areas on the plants' leaves before you began your experiment.

**Conclusions:**

Use your data and observations to explain how acid rain affects land plants.

3c Water Pollution

- (2) **Cleaning up Oil Spills.** When an oil tanker spills oil at sea, many organisms are harmed. In this experiment, you can examine several methods that are used to clean up oil spills at sea.

**Materials:**

Four aluminum pie pans  
Motor oil, such as 10W30  
Tap water

Cotton balls  
Scraps of fabric  
Liquid dish washing detergent

Plastic straw  
Piece of cotton string, 12 inches long  
Paper towels  
Strips of newspaper

Four plastic spoons  
Measuring cups and spoons

**Procedures:**

1. Label the pie plates A,B,C, and D.
2. Pour 1 cup of tap water into each pie plate.
3. Add 2 tablespoon of oil to the water in each pie plate.
4. In pan 1, use a plastic spoon to stir the oil into the water. Then, using a straw, try to blow the oil into one part of the pan.
5. In pan b, use a clean spoon to stir the oil. With a piece of string, try to collect the oil and contain it in one area.
6. Stir the oil in pan C with a clean spoon. using a paper towel, try to absorb the oil. Then use strips of newspaper, cotton balls, and fabric scraps to try to absorb the oil.
7. Use the last plastic spoon to stir the oil in pan d. Add 1 teaspoon of liquid dish washing detergent to the water in the pan.
8. At the end of your experiment, collect the remaining oil and take it to a gas station or oil recycling center for proper disposal.

**Observations:**

1. What happens when you use a straw to blow the oil away?
2. What cleanup method does using a piece of string represent?
3. Which of the materials used in pan C worked best to absorb the oil? Would this be a useful tool in actual oil spills at sea?
4. What happened when you added liquid dish washing detergent to pan D? Can you explain why?

**Conclusions:**

Scientists have tried many methods to clean up oil spills. In this experiment, you explored several. Explain which treatment worked best to clean up your oil spill. Would this type of treatment work in an actual spill at sea? Don't overlook the organisms that oil spills affect. is your treatment better or worse for them than the effects of the spill itself? If you were in charge of cleaning up an oil spill at sea, which method would you recommend?

1. 3d Land Pollution

**Oil Pollution on Land.** What happens to the oil that leaks out of engines onto asphalt parking lots? When it rains, that oil is washed onto the soil, where it seeps down toward plant roots. In this experiment, you can find out how oil pollution on land affects plants.

**Materials**

Four small plants in pots  
Measuring cups and spoons  
Aged tap water (water that has been collected and allowed to sit for 24 hours)

Oil, such as 10W30 motor oil  
Labels and marking pen  
Ruler  
Magnifying glass

**Procedures**

1. Label each small plant A, B, C, D.
2. On day 1, place the four plants in a sunny window. Water each plant with the same amount of aged tap water.
3. Examine each plant. In you notebook, record their heights, number of leaves, and any other important characteristics you observe.
4. Pour 1 teaspoon of motor oil on the soil of plant B, making sure not to get any oil on the leaves. Pour 2 teaspoons of motor old on the soil of plant C. Pour 3 teaspoons of motor oil on the soil of plant D. Do not put any oil on

- the soil of plant A.
- On day 2, water each plant with half of cup of aged tap water. Do not overwater the plants.
  - Examine each plant daily for the next three days (day 3, day 4, and day 5). Write your observations in your notebook. On the last day, again measure the height of each plant and record the number of leaves. Also record in your notebook any color changes that you see.
  - At the end of your experiment, dispose of the soil contaminated with oil. Contact your local environmental protection agency or hazardous waste agency to find out where to take the soil for proper disposal.

### **Observations**

- Why was it necessary not to put any oil on the soil of plant A?
- Why water the plants after pouring oil on the soil? What environmental conditions did this action imitate?
- What kinds of effects did you expect to see in the plants that were treated with oil? Did these effects appear?

### **Conclusions**

Oil is one of the many toxic substances that can be washed onto soil. Explain why it is important to collect used oil from filling stations and garages for recycling. What over substances could cause land pollution.

### **Love Canal**

For 11 years, the Hookere Chemicals and Plastics company of Niagara Falls, New York, produced hazardous wastes, sealed them in steel drums, and dumped the drums into an old canal called Love Canal. In 1953, Hooker Chemicals filled the canal with clay and topsoil, then sold the land to the Niagara Falls school board. Over the next 25 years, homes and an elementary school were built on the site. In 1976, residents of Love Canal began to complain to city officials about chemical smells. By 1977, chemicals began leaking from the corroded steel drums into storm sewers, basements of homes, and the school playground. State officials closed the school and evacuated 239 homes built above the canal. In 1980, Love Canal was declared a federal disaster area. By 1991, the total cost to clean up Love Canal and relocate its residents was about \$275 million

**Soil Erosion.** In this experiment, you can find out how soil erosion happens and learn of one way to prevent soil erosion.

### **Materials**

Three long, thin boxes made out of wood	Three bricks
Plastic bags	Measuring cups
Garden soil	Cut strips of newspaper
Soil with grass growing in it; can be sod or dug up from your yard	Bucket
Adhesive or duct tape	Shovel or garden trowel
Scissors	Ruler
Watering can	Notebook
	Pen or pencil

### **Procedures**

- Get permission before you dig up any soil for this experiment.
- Place cut-up strips of newspaper into a bucket and fill with water. Stir occasionally. Leave the newspaper in the water until it falls apart and becomes a slurry of paper and water. This may take a few days.
- Build three long, thin boxes out of wood. Cover the seams with duct tape to seal them.
- At one end of each box, cut a large V-shaped notch about half as deep as

- the end wall of the box. Label the boxes 1, 2, and 3.
5. Fill boxes 1 and 2 with garden soil so that the surface of the soil is about half an inch below the top edges of the boxes.
  6. Fill box 3 with soil that has grass growing on it. Make the soil surface about half an inch below the top edge of the box.
  7. Drain the water from the bucket of newspaper slurry. Take a handful of slurry, squeeze out more water, and spread this on top of the soil in box 2. Continue to do this until the surface of the soil in box 2 is covered with newspaper slurry. Let it sit overnight.
  8. The following day, line up the three boxes in a row. Place a brick under the uncut end of each box. Place a collecting pan, jar, or cup under the lower end of each box below the cut-out V.
  9. Fill the watering can with a measured amount of tap water. Standing at the higher end of box 1, sprinkle the water on the soil surface until the can is empty. Wait about 3 minutes until the water stops running from the V notch, then observe the water that collects in the pan, jar, or cup. Measure the amount of water and note its color. Record the data in your notebook.
  10. Repeat step 9 for boxes 2 and 3, using the same amount of water each time.

### **Observations**

1. Was there a difference in the path the water took in each of the three boxes?
2. How much water ended up in each collecting pan after 3 minutes? What was the color of the water in each collecting pan?
3. Was there a difference in the color and the amount of water in each collecting pan after 3 minutes?
4. How much soil ended up in each collecting pan?
5. The newspaper slurry used in box 2 resembles a slurry sprayed on bare soil at construction sites to prevent erosion. Based on your experiment, do you think this is a good idea?

### 3e Endangered Species Do ONE of these two.

Do research on one endangered species found in your state. Find out what its natural habitat is, why it is endangered, what is being done to preserve it, and how many individual organisms are left in the wild. Prepare a 100-word report about the organism, including a drawing. Present your report to your patrol or troop.

Do research on one species that was endangered or threatened but which has now recovered. Find out how the organism recovered, and what its new status is. Write a 100-word report on the species and discuss it with your counselor.

### 3f Resource Recovery

**Biodegradable Packing Materials.** Packing materials such as shredded newspaper or foam peanuts sometimes end up as litter along roadsides, or take up space in landfills. In this experiment, you can find out which packing materials are biodegradable.

#### **Materials**

Sand	Labels and marking pen
Garden soil	Tap water
Small shovel or garden trowel	Four plastic bags and twist ties
Strips of newspaper	Ruler
Foam packing peanuts	Measuring cup
Popped popcorn	Magnifying glass
Small piece of plastic bubble wrap	Sheets of newspaper

### **Procedures**

1. Label the plastic bags 1, 2, 3, and 4.
2. Pour a cup of sand into each plastic bag. Then add a cup of garden soil to each bag. Carefully mix the sand and soil by squeezing the mixture in each bag.
3. In bag 1, place six small strips of newspaper.
4. In bag 2, place six foam packing peanuts.
5. In bag 3, place six pieces of popped popcorn.
6. In bag 4, place a small piece of plastic bubble wrap.
7. Fill each bag almost to the top with garden soil. (Leave enough space to allow the bag to be closed with a twist tie.)
8. Pour half a cup of tap water into each plastic bag.
9. Close each bag with a twist tie. Place all four bags in a sunny window.
10. After two days, open the plastic bags, stir the soil, add half a cup of tap water, and reclose the bags.
11. Wait three days, then empty each bag onto a sheet of newspaper and look for the packing materials in each. Use a magnifying glass to examine each material.

### **Observations**

1. Which of the packing materials showed signs of decomposing?
2. Which were biodegradable? Which were nonbiodegradable?
3. Explain the differences between the materials that make them biodegradable or nonbiodegradable.

### **Conclusions**

Based on the results of this experiment, make a statement about what kinds of packing materials would create less solid waste. Can you think of other kinds of biodegradable packing materials that would protect fragile items during transport?

## **Building an Ecosystem** (Requirement 4)

An ecosystem is a complicated system in which living and nonliving things interact. You can see these interactions on a farm, in your backyard, in a city park, or in a vacant lot. But can you build a working ecosystem yourself? Find out by doing this project.

### **Materials**

Empty, clear 2-liter plastic soda pop bottle	Scissors
Garden soil or soil from any outdoor area	Clear tape
Three or four small green plants such as grass and dandelions	Small gardening tools including a trowel
Small organisms such as ants, sow bugs, earthworms, and snails	Notebook
	Pen or pencil

### **Procedure**

1. Remove the colored base from the bottom of the soda pop bottle.
2. Fill the base with soil from an outdoor area. (Make sure you have permission to remove soil before you start digging.)
3. Plant three or four small plants in the soil.
4. Spray the plants and soil several times with tap water until the soil is damp.
5. Measure about 4 inches down from the neck of the bottle and cut off the top in a circle around the bottle. Discard the top.
6. Add a few small organisms to the soil.
7. Immediately flip the remaining part of the bottle over the colored base. Tape the bottle to the base.
8. Place your closed ecosystem in a window that gets at least four hours of sun daily.

### **Observations**

Observe your ecosystem-in-a-bottle every day for one week. Record your observations daily in a notebook. Your observations could include whether or not moisture collects on the inside of the bottle, how the organisms are doing, whether the plants look healthy, and so on.

### **Conclusions**

1. Explain what happened to the plants and organisms in your ecosystem.
2. Was your ecosystem in balance? How do you know?
3. What parts of your ecosystem-in-a-bottle would you consider to be nonliving?
4. How is your ecosystem like Earth? How is it different?
5. If your ecosystem failed before the week was up, what do you think caused it to fail? How could you improve your ecosystem so that it would not fail?
6. Describe at least three interactions that happened in your closed ecosystem.

## **Ecosystem Study** (Requirement 5)

Every ecosystem involves complicated interactions between the environment and the organisms that live there. You have learned about some of these interactions. In this project, you'll use this knowledge to study an ecosystem.

### **How to Choose a Study Area**

Locate a beach, pond, lake, forest, meadow, vacant lot, undeveloped land, or other natural area outdoors. Choose an area that includes at least two different types of ecosystems and the region between them (known as the ecotone) where they blend together. For example, you could choose any area where a grassy meadow blends into a forest, or where a sandy beach rises to a bayberry scrub woodland. You might choose an area such as your backyard and the desert, marsh, river, or grassland that begins just behind your neighborhood. You could study an area in a local park where a creek bank slopes to a stand of trees, or mowed grass meets a patch of weeds.

### **Beginning**

Once you have selected your study area visit the site and write your general observations in your notebook. Include the following:

- Types of ecosystems
- Weather
- Soil types
- Season
- Dominant species
- Trees
- Plants

After making general observations about your study area, select ONE of the following projects (A or B) to further investigate its ecology.

### **PROJECT A: STUDY PLOT**

In this activity, you will run a transect from one ecosystem type into another. You will study species diversity in each ecosystem and in the ecotone between them. (A transect is a continuous line marked off through a land area; it is used to identify the position of plots of land. Species diversity refers to the variety of living things found in an ecosystem.)

### **Materials**

12 small stakes such as tent stakes  
Three 10-yard pieces of string  
Hammer or rubber mallet  
Magnifying glass

Labels and marking pen  
Notebook  
Yardstick and ruler  
Field guide to plants

### **Procedures**

1. In your chosen study area, identify two ecosystem types and the ecotone between them.
2. Begin at one of the ecosystems. Using the yardstick, stakes, hammer, and a piece of string, mark out a square that measures 2 yards on each side. This is your first

- study plot. use a label and marking pen to label this plot 1.
3. Starting at one side of plot 1, walk to the second ecosystem in your study area. Repeat step 2 to define a second study plot. Label this plot 2.
  4. From plot 2 walk back toward plot 1 until you are in the ecotone where the two ecosystems blend together. Here repeat step 2 to define a third study plot. Label it plot 3.
  5. Sit beside plot 1. Begin your study by writing in your notebook information about all the nonliving factors around you. Note the date, time of day, temperature, and whether it is sunny or cloudy, windy or calm, rainy or dry. If any of these factors change as you observe the plot, make a note of the change. Note also whether the plot is flat or on a slope.
  6. Next look at the living things in the plot. If you can see any animals, note their common names or draw pictures in your notebook for later identification. Identify all of the different plants you see. Use a field guide to identify each species by name, or make a drawing of each in your notebook. Use a magnifying glass, if needed, to see the features of each animal or plant species for identification.
  7. Estimate how much space each plant species occupies in the plot. For example, in a grass meadow, one species of grass might occupy about 90 percent (nine-tenths) of the space in the plot. Record this estimate next to the name of each species in your notebook.
  8. Using a ruler or yardstick, measure the height (or estimate the height) of identified plant species. use these measurements to draw a side view of your study plot. Try to draw the plants to scale.
  9. Repeat steps 5, 6, 7, and 8 at plots 2 and 3.

### **Observations**

1. How many animal species did you identify in each study plot? How many plant species?
2. Was there a difference in the number of animal and plant species in each of the three study plots/
3. Were the same plant species found in each of the three plots?

### **PROJECT B: STUDY PLOT**

In this activity you will make four visits to the study area, staying for at least 30 minutes each time to observe the living and nonliving parts of the ecosystem. You may visit the study area four times on the same day (at dawn, during the day, at dusk, and at night), or you may visit at the same time of day on four consecutive days, or on one day during each of four seasons. Your results will vary depending upon when you choose to observe the area.

### **Materials**

Notebook	Tape recorder and cassette tape
Pen or pencil	(optional)
Binoculars (optional)	Camera (optional)
Magnifying glass	

### **Procedures**

1. Decide on your schedule for visiting the study area. Make sure your parents or counselor agrees with your plan.
2. On your first visit, arrive quietly, making as little noise as possible. Find a good place to observe wildlife, such as in the ecotone between the two ecosystems. make yourself comfortable and have your notebook and pen or pencil handy. Note the date, time of day, temperature, and other information such as whether it is windy, calm, sunny, cloudy, rainy, dry, etc. Note whether your study area is flat or on a slope. Draw a small map of the area in your notebook, showing how it looks from where you are sitting.
3. Once you are settled and have noted the environmental conditions, begin your 30-minute observation period. Identify any plants you see (by using field guides or by drawing them in your notebook for later identification). Note what stage of

its life cycle each plant species is in---that is, look for buds, leaves, flowers, seeds, and so on. Record these data in your notebook.

4. Each time you see an animal, write down the animal's common name and describe its behavior. If you don't know the animal's common name, make a drawing of it and note its size and color so that you can identify it later. If you have a camera (one that takes photographs quietly!), you may photograph the animal.
5. Note and describe any sounds the animals make. If you have a battery-operated tape recorder, turn it on and let it run for the 30-minute observation period. When an animal makes a sound, note the time in your notebook so that you can identify the taped sound later.
6. If you have binoculars, try to identify animals that are far away. For tiny organisms such as insects and worms, use a magnifying glass. Do not pick up any organisms. Your role is to observe, not to interact with living things.
7. After 30 minutes of study, mark your spot with a natural trail marker such as crossed sticks or a stone cairn. Collect your materials and leave quietly. Complete your notes by writing any observations that you weren't able to note during the study period.
8. Visit the area and repeat your observations three more times, according to the schedule you set up in step 1. Be sure to observe from exactly the same spot each time.

### **Observations**

1. Did you observe any changes in the plant species that you identified during your study periods?
2. Did you see more animals during any particular observation period? What were the animals doing?
3. Did the time of day or season make any difference in your observations?
4. Did environmental conditions have an effect upon your observations.

### **Conclusions (PROJECT A OR B)**

Write a report, based on your observations. Include your general observations about the ecology of your study area. Also include your findings and conclusions from your detailed study.

# Assessing Environmental Impact

(Requirement 6)

Now that you have seen how human activities affect the biosphere, you can begin to understand how hard it is to predict all the environment effects of any project. What might seem like a simple project---building a new house, for example---may have many environmental impacts beyond simply disturbing the soil on the building site. What happens to the moles and shrews that live in the soil? What happens to the red fox and the great horned owl that prey upon the moles and shrews? How will soil erosion from the site be controlled during construction? Will the topsoil be saved and put back on the site after the house is built?

You can see that there may be a lot of environmental impacts to think about when building a house. Now imagine the possible effects if you were building 100 houses in a new development, a highway, or a bridge over a river.

### **Environmental Impact Statements**

When a federal agency proposes new laws or actions that may affect the environment, it is required by law to prepare an environmental assessment (EA) or an environmental impact statement (EIS). Federal, state, and local agencies and the general public get the chance to review the proposed activity before the agency can go ahead with it.

The EIS must discuss five environment concerns:

- The environmental impact of the proposed action
- Any harmful environmental effects that cannot be avoided
- Alternatives to the proposed action
- Short-term use of the environment vs protecting the environment's long-

term health.

- Any permanent commitments of resources

A formal EIS may be hundreds or even thousand of pages long. It describes the proposed project, discusses the project's possible impact upon the various ecosystems that will be affected, and suggests ways to reduce the potential impact upon those ecosystems.

In this activity, you will complete a one-page environmental impact assessment for an imaginary construction project in your community. Although your assessment will be shorter than a real environmental impact statement, you will address some of the same issues.

### **Materials**

Notebook

Pen or pencil

Camera and film (optional)

Fieldguide to organisms found in the proposed project area

### **Procedure**

1. In your notebook, describe a hypothetical (imaginary) construction project proposed by your local or state government. Include a description of the size and nature of the project and how the community will benefit from it. Suggested projects include building a new highway or bridge in a rural area, building a new school on farmland, building a bicycle path or nature trail in a wooded area, or paving over a vacant lot for parking cars.
2. Visit the site of the project and describe what now exists there. (Although the project is imaginary, the site must be a real place.) Include the following:
  - a. Plant and animal life at the site
  - b. Type of ecosystem (forest, grassland, desert, etc.)
  - c. Whether the area has been disturbed before
  - d. Whether the site includes habitat for an endangered or threatened species.
  - e. Whether the site slopes and the soil would be in danger of erosion during construction
  - f. The presence of streams, ponds, swamps, or other wetlands on the site.
  - g. If the site has important fossils or artifacts
  - h. Activities on lands next to the site.
3. Describe how the proposed project fits into existing plans for the area. For example, is the site the last empty lot in a housing subdivision? Will a highway cut through a state or local park? Will a bike path allow area residents to bicycle to school or work rather than drive cars?
4. Suggest ways the proposed project will likely affect the environment. Answer the following questions:
  - a. Will the project cause soil erosion?
  - b. Will it destroy forests, grasslands, deserts, or other ecosystems?
  - c. Will it disturb any habitats of endangered or threatened species/
5. Identify any effects of the project that probably will be harmful but cannot be avoided. A bridge over a river to connect tow existing roads, for example< probably cannot be built elsewhere, so the project's effects may have to be accepted even if they're harmful.
6. Suggest alternatives to the proposed project that would protect the environment, yet still meet the needs of people. Alternatives may include different project designs at the same site, or the same project built at a different site.
7. Discuss the trade -offs between the short- and long-term environmental losses and the short-and long-term benefits of the proposed project.
8. Determine how the proposed project would permanently prevent other uses of the site. If a vacant lot is paved, for example, then that land could not be used for a community garden or a playground.

### **Observations**

1. What type of ecosystem is now found at the proposed project site?
2. How will the proposed project affect the living and nonliving parts of the ecosystem at the site?

3. What alternatives are there to locating the project at this site? What else could be done?
4. How will the proposed project benefit people?
5. How will the site be permanently changed if the project goes ahead?

### **Conclusions**

Based on your review of the proposed project, tell your counselor whether you think the project should go ahead as designed, or be stopped. If you recommend stopping the project, tell why and suggest any alternative designs or projects that you would support.

# Design an Environmental Project

(Requirement 7)

There are many ways you, your family, your troop, and your community can respond to environmental problems such as air pollution, water pollution, and land degradation. In this activity, you will design a project that could help to solve an environmental problem, reduce an environmental impact, or affect environmental awareness in your community.

Designing and presenting this project idea shows that you---one individual with the help of your troop, local government, and community---can make a difference.

### **Materials**

Posterboard

Computer printer paper

Notebook

Colored felt-tip markers

Pen or pencil

Stamps and envelopes

### **Procedures**

1. Think of an environmental problem that you would like to help solve. Perhaps you live near a river that has been used as a dumping ground for solid wastes such as old tires, metal shopping carts, plastic bags, or whatever. Maybe a local industry is polluting the air or water in your community. Perhaps you have seen younger children littering as they walk home from school. Maybe you'll decide to produce a video on endangered species to use on public television.
2. After you decide what environmental problem you would like to help solve, discuss it with your counselor before you design a project to address the problem.
3. Make a purpose statement. That is, state what problem you intend to address, and how you propose to address the problem. If you want to clean up solid wastes in a local river, your purpose statement might be: "For years, Alum Creek has been used as a dumping ground for solid wastes. These wastes affect the living things in and around the creek, and are unsightly. I propose that my troop enlist the community's help to sponsor and hold a community-wide Alum Creek Cleanup Day." Make your purpose statement as specific as possible. Write your purpose statement in your notebook.
4. Design a project that will accomplish the purpose you have stated. Begin by listing the various tasks that must be done to prepare for your project. For example, you might list the following for a Creek Cleanup Day:
  - ▣ Call local government agencies to find out if your troop needs permission or a permit to work on cleaning up the creek.
  - ▣ Ask the city council or other governing body if it will sponsor such a project, and what help it might offer your troop.
  - ▣ Propose a date and time for the cleanup project, then check with the local government to make sure they date doesn't conflict with any other community activity.
  - ▣ Present the project idea to your troop and ask Scouts and adult leaders to commit to the project.
  - ▣ Identify the resources you will need to complete the project, such as trucks to haul away the garbage collected.
  - ▣ Find out where you can legally and safely place the garbage that you plan to

collect from the creek.

- Find out if there are any disease-causing organisms in the water and, if there are, how worker should protect themselves from such organisms.
- Prepare an emergency preparedness plan to ensure that first aid kits will be available and someone is designated to respond to any injuries during the cleanup.
- Find out if local businesses will donate materials for posters to advertise the date and time, or donate plastic garbage bags, plastic gloves, or other items needed for the cleanup.

After you have listed all the tasks that your would have to be done, decide which ones your troop could do and which you would need help with. Decide how to assign each task to a specific person or group. In your notebook, write down the tasks and the people you would assign to them.

5. Complete your project design by making a poster, pamphlet, or other advertisement for the project. Prepare this material as if you were actually going to do the project.
6. Present your project design to your troop.

### **Observations**

1. What environmental problem are you addressing in your proposed project?
2. Why is it important to make a purpose statement before your design a project like this?
3. Do you think your troop could accomplish your project? Why or why not/
4. Could you redesign your project to make it less complex or costly, but still accomplish your goal?

### **Conclusions**

Sometimes environmental problems seem overwhelming, but the work of just one person or a small group of people can begin to solve these problems. Brainstorm with your patrol or troop to find out what environmental problems they would like to address. Then suggest that your troop plan and carry out a project to solve a local environmental problem.

# Careers in Environmental Science

(Requirement 8)

You should like science, the outdoors and people.

Agronomists: Study plants and the soil to find ways to improve quality and yield of crops.

Botanists: Study all aspects of plant life.

Horticulturists: Work with orchard and garden plants. They may work to breed new kinds of plants.

Landscape Architects: Supervise the arrangement of outdoor areas.

Range Scientists: Manage, improve, and protect the vegetation of our rangelands.

Foresters: Plan and supervise the growing an harvesting of trees, and work to protect trees from fire, harmful insects, and disease.

Soil Scientists and Conservationists: Study the characteristics an behavior of soils and develop ways to best use our resources without damaging them.

Wildlife Conservationists: Protect wildlife and their habitats through the use of life processes, genetics, ecology, behavior, diseases, nutrition, population changes, and chemistry of animal life.

Biochemists: Study the chemistry of life. Much of their work is directed toward finding out how organisms of all types respond to chemical pollutants in the air, water, and soil.

Entomologists: Study insects and their relationships to plants and other animals.

Geneticists: Work to develop hereditary characteristics to produce better plants and

animals.

Microbiologists: Study the growth, structure, and general characteristics of bacteria, viruses, and molds. Much of this work today is directed toward developing strains to help “eat up” various forms of pollution such as oil slicks.

Oceanographers: Study the movements, physical properties, and plant and animal life of the oceans.

Chemists: Work to develop new devices to clean up chemical pollutants in air and water.

Geologists, physicists, geophysicists, and meteorologists: Work to make contributions to environmental protection.

Environment Engineering: Work to protect the environment.

Chemical Technicians: Often work for companies making equipment to analyze pollution. They go into the field to teach the companies how to use the equipment.

Instrument Technicians: Work with many kinds of instruments that are used to study the atmosphere and rivers, lakes, and oceans, which allow scientist to track down pollution.

Forestry Aides: Work in fire control, fire prevention, range management, forest engineering, and surveying. They assists foresters.

Forestry Technicians: Work with timber sales, recreational development, or research activities. They collect and analyze information about forests, work with the public, supervise construction crews, and perform other important functions.

Range or Soil Conservation Aides: Work with soil conservationists to help develop such things as erosion-control and irrigation systems.

Fishery Aides: Work at hatcheries, go on stocking trips, and assist in tagging fish for study, among other duties.

Game Management Agents: Conservation officers who enforce laws and regulations that protect fish and wildlife.

Environmental Health Inspectors: Ensure that food, water, and air meet government standards.

Environmental Analysts: Conduct research and develop ways to control pollution problems. They identify and analyze sources of pollution to determine their effects. They then set standards and develop ways to control pollution problems.

# **BOY SCOUT TROOP 238**

## **Environmental Science Merit Badge**

1. Make a time line of the history of environmental science in America. Identify the contribution made by the Boy Scouts of America to environmental science. Include dates, names of people or organizations, and important events.

2. Define the following terms and describe the relationships among them: population, community, ecosystem, biosphere, symbiosis, niche, habitat, conservation, threatened species, endangered species, extinction.

Population

Community

Ecosystem

Biosphere

Symbiosis

Niche

Habitat

Conservation

Threatened Species

Endangered Species

Extinct

3. Do ONE activity in EACH of the following categories (using the activities outlined in this handout as the bases for planning and carrying out your projects):

a. Ecology

- (1) Conduct an experiment to find out how living things respond to changes in their environments. Discuss your observations with your counselor.

What did the worms do at the beginning of the experiment?

\_\_\_\_\_

How much time did the worms spend in the lighted part of the shoe box?\_\_\_\_\_ In the shaded part of the box?\_\_\_\_\_

What nonliving environmental factor does the lamp represent?

\_\_\_\_\_

What is phototropism?\_\_\_\_\_

\_\_\_\_\_

Did the worms show positive or negative phototropism?\_\_\_\_\_

Why would earthworms react this way to light?\_\_\_\_\_

- (2) Conduct an experiment illustrating the greenhouse effect. Keep a journal of your data and observations. Discuss your conclusions with your counselor.

Did the temperature in each bottle change during your experiment?\_\_\_\_\_ In what way?\_\_\_\_\_

Explain what the lightbulb and the plastic wrap represent in this model of the greenhous effect?\_\_\_\_\_

\_\_\_\_\_

Compare you r experimental setup to real conditions on earth.

\_\_\_\_\_

Why does the greenhouse effect make it possible for life to exist on earth?\_\_\_\_\_

b. Air Pollution

- (1) Perform an experiment to test for particulates that contribute to air pollution. Discuss your findings with your counselor.

What is the average number of particulates on the collector left in the urban environment?\_\_\_\_\_ In a rural enviroment?\_\_\_\_\_ Is there a difference in the average number of particulates found

on the two collectors?\_\_\_\_\_

Using your data, report what you learned about how particulates contribute to air pollution in urban and rural environments>\_\_\_\_\_

- (2) Conduct a study to test the effects of acid rain on plants. Discuss your findings with your counselor.

Did you see any changes in the leaves of plant 1 during the experiment?\_\_\_\_\_ Plant 2?\_\_\_\_\_ Plant 3?\_\_\_\_\_ Plant 4?\_\_\_\_\_ Plant 5?\_\_\_\_\_

If you saw changes, what kind of changes did you see?\_\_\_\_\_

Normal rainwater has a pH of about 5.6. Did any of the plants in the experiment receive treatment that compared to normal rain?

Explain why you drew a picture of the damaged areas on the plants' leaves before you began your experiment.\_\_\_\_\_

Use your data and observations to explain how acid rain affects land plants.\_\_\_\_\_

c. Water Pollution

- (1) Conduct an experiment to show how living things react to thermal pollution. Discuss your observations with your counselor.

Why did you record the number of goldfish in each half of the tank or container at the beginning of the experiment?\_\_\_\_\_

What happened to the water temperature in the half nearest the heater?\_\_\_\_\_

How do gold fish respond to rising water temperatures?\_\_\_\_\_

Using your data, explain how thermal pollution may affect organisms that live in water..\_\_\_\_\_

How would thermal pollution affect water plants or other organisms that cannot move away from the source of the heat?

- (2) Conduct an experiment to identify the methods that could be used to mediate (reduce) the effects of an oil spill on waterfowl. Discuss your results with your counselor.

What happens when you use a straw to blow the oil away?\_\_\_\_\_

\_\_\_\_\_

What cleanup method does using a piece of string represent?\_\_\_\_\_

\_\_\_\_\_

Which of the materials used in pan C worked best to absorb the oil?\_\_\_\_\_

Would this be a useful tool in actual oil spills at sea?\_\_\_\_\_

\_\_\_\_\_

What happened when you added liquid dishwashing detergent to pan D?\_\_\_\_\_

Can you explain why?\_\_\_\_\_

\_\_\_\_\_

Which treatment worked bet to clean up your oil spill?\_\_\_\_\_

\_\_\_\_\_

Would this type of treatment work on an actual oil spil at sea?\_\_\_\_\_

Is you treatment better or worse for the organisms than the effects of the oil spill itself?\_\_\_\_\_

If you were in charge of cleaning up an oil spill at sea, which

methold would you recommend?\_\_\_\_\_

d. Land Pollution

- (1) Conduct an experiment to illustrate soil erosion by water. Take photographs or make a drawing of the soil before and after your experiment, and make a poster showing your results. Present your poster to your patrol or troop.

Was there a difference in the path the water took in each of the three boxes?\_\_\_\_\_

How much water ended up in each collecting pan after 3

minutes?\_\_\_\_\_

What was the color of the water in each collecting pan?\_\_\_\_\_

\_\_\_\_\_

Was there a difference in the color and the amount of water in each collecting pan after 3 minutes?\_\_\_\_\_

\_\_\_\_\_

How much soil ended up in each collecting pan?\_\_\_\_\_

The newspaper slurry used in box 2 resembles a slurry sprayed on bare soil at construction sites to prevent erosion. Based on your experiment, do you think this is a good idea?\_\_\_\_\_ Based on your data from this experiment, explain why growing plants on soil can help prevent soil erosion?\_\_\_\_\_

- (2) Perform an experiment to determine the effect of an oil spill on land. Discuss your conclusions with your counselor.  
Why was it necessary not to put any oil on the soil of plant A?\_\_\_\_

Why water the plants after pouring oil on the soil? \_\_\_\_\_

What environmental conditions did this action imitate?\_\_\_\_\_

What kinds of effects did you expect to see in the plants that were treated with oil?\_\_\_\_\_

Did those effects appear?\_\_\_\_\_

Oil is one of many toxic substances that can be washed onto soil. Explain why it is important to collect used oil from filling stations and garages for recycling.\_\_\_\_\_

What other substances could cause land pollution? \_\_\_\_\_

e. Endangered Species

- (1) Do research on one endangered species found in your state. Find out what its natural habitat is, why it is endangered, what is being done to preserve it, and how many individual organisms are left in the wild. Prepare a 100-word report about the organism, including a drawing. Present your report to your patrol or troop.
- (2) Do research on one species that was endangered or threatened but which has now recovered. Find out how the organism recovered, and what its new status is. Write a 100-word report about the species and discuss it with your counselor.

f. Resource Recovery

- (1) Perform an experiment on packaging materials to find out which ones are biodegradable. Discuss your conclusions with your counselor.  
Which of the packing materials showed signs of decomposing?

Which were biodegradable?\_\_\_\_\_

Which were nonbiodegradable?\_\_\_\_\_

Explain the differences between the materials that make them biodegradable or nonbiodegradable.\_\_\_\_\_

Based on the results of this experiment, make a statement about what kinds of packing materials would create less solid waste.

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Can you think of other kinds of biodegradable packing materials that would protect fragile items during transport?\_\_\_\_\_

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- (2) Find out if your local community has a recycling program in effect. If it does, find out what items are recycled, and who pays for

recycling.\_\_\_\_\_

If your community does not have a recycling program, write questions for and conduct a survey on recycling. Include questions about attitudes toward recycling, what should be recycled, and your community's willingness to support a recycling program. discuss your findings with your counselor.

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4. Build an ecosystem in a bottle. Include soil, plants, fungi, and small animals found in your local environment. Maintain the ecosystem for one week. Observe it daily, and keep a record of your observations. Discuss your observations with your counselor.

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5. Choose an outdoor area to study. In your study area do ONE of the following:
- Mark off three study plots of 4 square yards(2 yards by 2 yards or 1 yard by 4 yards) each, and count the number of species found there. Then estimate how much space is occupied by each species found in the plots. Write a report that adequately discusses the biodiversity and population density of your study area. Discuss your report with your counselor.
  - Make four visits to the study area, staying for at least 30 minutes each time, to observe the living and nonliving parts of the ecosystem. Keep a journal of your observations, including a discussion of differences noted during the four visits. Write a report on your observations and discuss it with your counselor.

6. Propose a hypothetical construction project in your community and prepare a limited environmental impact statement for the project. Study the area to see what the impact of the project might be upon the living and nonliving parts of the ecosystem.

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7. Design a project that would help solve an environmental problem, reduce an environmental impact, or affect environmental awareness in your community. Include plans for a specific project that could be done by your patrol or troop.\_\_\_\_\_

8. Discuss three possible careers in the field of environmental science. Identify the education that you would need to pursue ONE of these careers.