Environmental Science Merit Badge

Troops 344 & 9344
Pemberville, OH

Environmental Science Merit Badge Requirements

1. Make a timeline 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: population, community, ecosystem, biosphere, symbiosis, niche, habitat, conservation, threatened species, endangered species, extinction, pollution prevention, brownfield, ozone, watershed, airshed, nonpoint source, hybrid vehicle, fuel cell.

Environmental Science Merit Badge Requirements

3. Do ONE activity from seven of the following categories (using the activities in the merit badge pamphlet as the basis 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.
   3. Discuss what is an ecosystem. Tell how it is maintained in nature and how it survives.

Environmental Science Merit Badge Requirements

3. Do ONE activity from seven of the following categories (using the activities in the merit badge pamphlet as the basis for planning and carrying out your projects):

   b. Air Pollution

   1. Perform an experiment to test for particulates that contribute to air pollution. Discuss your findings with your counselor.
   2. Record the trips taken, mileage, and fuel consumption of a family car for seven days, and calculate how many miles per gallon the car gets. Determine whether any trips could have been combined (chained) rather than taken out and back. Using the idea of trip chaining, determine how many miles and gallons of gas could have been saved in those seven days.
   3. Explain what is acid rain. In your explanation, tell how it affects plants and the environment and the steps society can take to help reduce its effects.

Environmental Science Merit Badge Requirements

3. Do ONE activity from seven of the following categories (using the activities in the merit badge pamphlet as the basis for planning and carrying out your projects):

   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.
   3. Describe the impact of a waterborne pollutant on an aquatic community. Write a 100-word report on how that pollutant affected aquatic life, what the effect was, and whether the effect is linked to biomagnification.

Environmental Science Merit Badge Requirements

3. Do ONE activity from seven of the following categories (using the activities in the merit badge pamphlet as the basis for planning and carrying out your projects):

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.
3. Photograph an area affected by erosion. Share your photographs with your counselor and discuss why the area has eroded and what might be done to help alleviate the erosion.

Environmental Science Merit Badge Requirements

3. Do ONE activity from seven of the following categories (using the activities in the merit badge pamphlet as the basis for planning and carrying out your projects):

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 on the species and discuss it with your counselor.
3. With your parent's and counselor's approval, work with a natural resource professional to identify two projects that have been approved to improve the habitat for a threatened or endangered species in your area. Visit the site of one of these projects and report on what you saw.

Environmental Science Merit Badge Requirements

3. Do ONE activity from seven of the following categories (using the activities in the merit badge pamphlet as the basis for planning and carrying out your projects):

   f. Pollution Prevention, Resource Recovery, and Conservation

   1. Look around your home and determine 10 ways your family can help reduce pollution. Practice at least two of these methods for seven days and discuss with your counselor what you have learned.
   2. Determine 10 ways to conserve resources or use resources more efficiently in your home, at school, or at camp. Practice at least two of these methods for seven days and discuss with your counselor what you have learned.
   3. Perform an experiment on packaging materials to find out which ones are biodegradable. Discuss your conclusions with your counselor.

Environmental Science Merit Badge Requirements

3. Do ONE activity from seven of the following categories (using the activities in the merit badge pamphlet as the basis for planning and carrying out your projects):

   g. Pollination

   1. Using photographs or illustrations, point out the differences between a drone and a worker bee. Discuss the stages of bee development (eggs, larvae, pupae). Explain the pollination process, and what propolis is and how it is used by honey bees. Tell how bees make honey and beeswax, and how both are harvested. Explain the part played in the life of the hive by the queen, the drones, and the workers.
   2. Present to your counselor a one-page report on how and why honey bees are used in pollinating food crops. In your report, discuss the problems faced by the bee population today, and the impact to humanity if there were no pollinators. Share your report with your troop or patrol, your class at school, or another group approved by your counselor.
   3. Discuss with your counselor the effectiveness of native bees as pollinators. Identify some of the native bees found in your area. Construct and install a native bee house.

Environmental Science Merit Badge Requirements

3. Do ONE activity from seven of the following categories (using the activities in the merit badge pamphlet as the basis for planning and carrying out your projects):

h. Invasive Species

1. Learn to identify the major invasive plant species in your community or camp and explain to your counselor what can be done to either eradicate or control their spread.
2. Do research on two invasive plant or animal species in your community or camp. Find out where the species originated, how they were transported to the United States, their life history, how they are spread, and the recommended means to eradicate or control their spread. Report your research orally or in writing to your counselor.
3. Take part in a project of at least one hour to eradicate or control the spread of an invasive plant species in your community or camp.

Environmental Science Merit Badge Requirements

4. Choose two outdoor study areas that are very different from one another (e.g., hilltop vs. bottom of a hill; field vs. forest; swamp vs. dry land). For BOTH study areas, do ONE of the following:
   a. Mark off a plot of four square yards in each study area, and count the number of species found there. Estimate how much space is occupied by each plant species and the type and number of nonplant species you find. Report to your counselor orally or in writing the biodiversity and population density of these study areas. Discuss your report with your counselor.
   b. Make at least three visits to each of the two study areas (for a total of six visits), staying for at least 20 minutes each time, to observe the living and nonliving parts of the ecosystem. Space each visit far enough apart that there are readily apparent differences in the observations. Keep a journal that includes the differences you observe. Discuss your observations with your counselor.

Environmental Science Merit Badge Requirements

5. Using the construction project provided or a plan you create on your own, identify the items that would need to be included in an environmental impact statement for the project planned.
6. Find out about three career opportunities in environmental science. Pick one and find out the education, training, and experience required for this profession. Discuss this with your counselor, and explain why this profession might interest you.

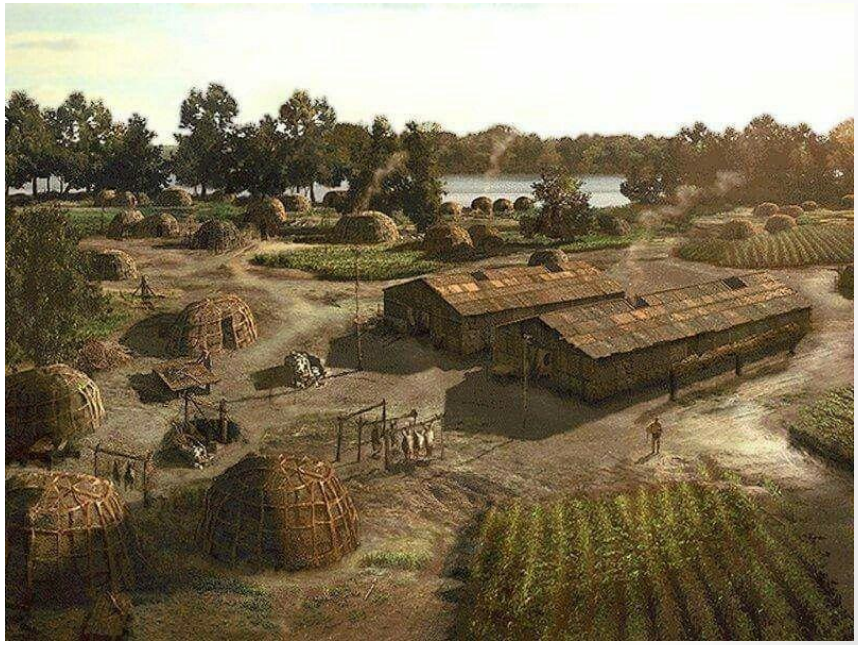
Requirement 1: Timeline

1. Make a timeline 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.

Requirement 1: Timeline

Native Americans

- Native Americans often manipulated their local environments and profoundly shaped the ecosystems around them.
  - The burning of forest to improve hunting established the Oak Openings region in northwest Ohio and southeast Michigan.
- It was common for some tribes to clear land for farming by cutting and burning forests.
  - Once cleared, fields were farmed extensively until soil fertility was depleted; then they cleared new lands and started the process again.
- Similarly, where game was plentiful, Indians used only the choicest cuts and left the rest.



Requirement 1: Timeline

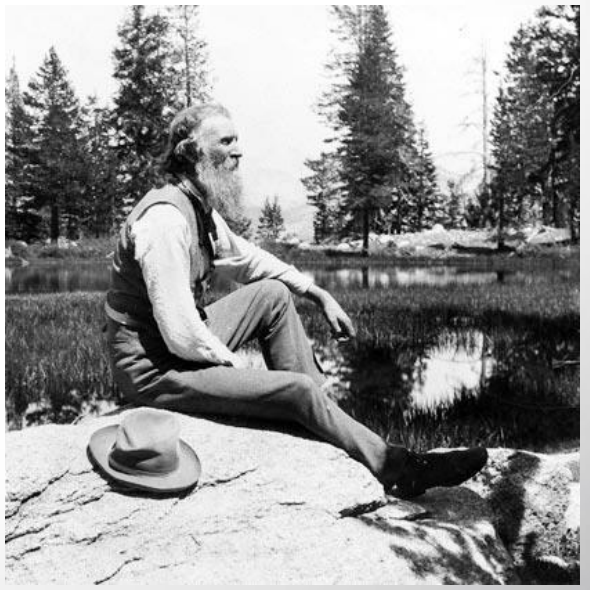
Yellowstone National Park

- Established by the U.S. Congress and signed into law by President Ulysses S. Grant on March 1, 1872.
- Yellowstone was the first national park in the U.S. and is also widely held to be the first national park in the world.

Requirement 1: Timeline

Sierra Club

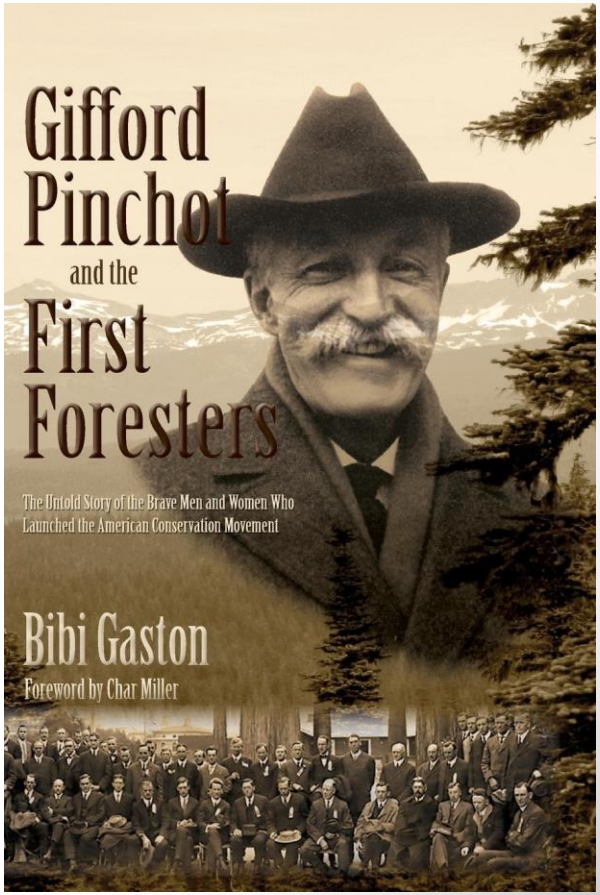
- The **Sierra Club** is an environmental organization in the United States.
- It was founded on May 28, 1892, in San Francisco, California, by the Scottish-American preservationist John Muir.



Requirement 1: Timeline

Gifford Pinchot

- The scale of environmental devastation in the United States traces its origins to early colonialism.
- Colonialists saw “new” territories as places with seemingly inexhaustible natural resources to exploit, with little consideration for the long-term impacts.
- The idea of conservation only began to gain popularity in the United States at the end of the 1800s.
- Gifford Pinchot founded the conservation movement in the United States in the late 1890s.
- Pinchot's ideas were inspired by his observations of environmental destruction and unregulated wilderness exploitation during the 1800s.
- Pinchot had great influence during the presidency of Theodore Roosevelt and he helped to steer conservation policies from the turn of the century until the 1940s.



Requirement 1: Timeline

President Theodore Roosevelt 1901-1909

- The conservation legacy of Theodore Roosevelt is found in the 230 million acres of public lands he helped establish during his presidency.
- Roosevelt created the present-day USFS in 1905 to conserve forests for continued use.
- Roosevelt wanted to insure the sustainability of those resources.

Roosevelt and John Muir in Yosemite Valley

Requirement 1: Timeline

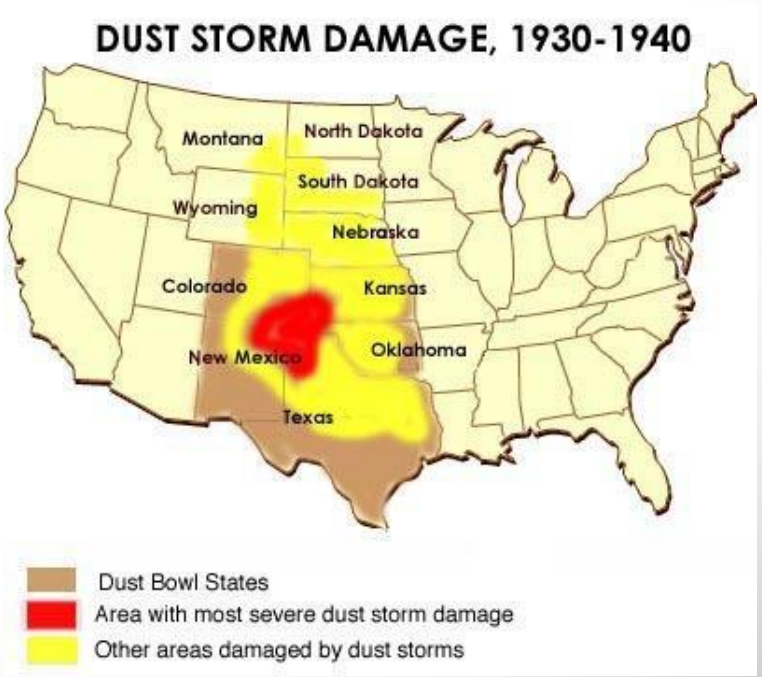
US Forest Service

- Congress created the US Forest Service in 1905.
- The Forest Service manages 193 million acres (780,000 km^2) of land.
- Forest Service's mission is to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations.

Requirement 1: Timeline

Dust Bowl

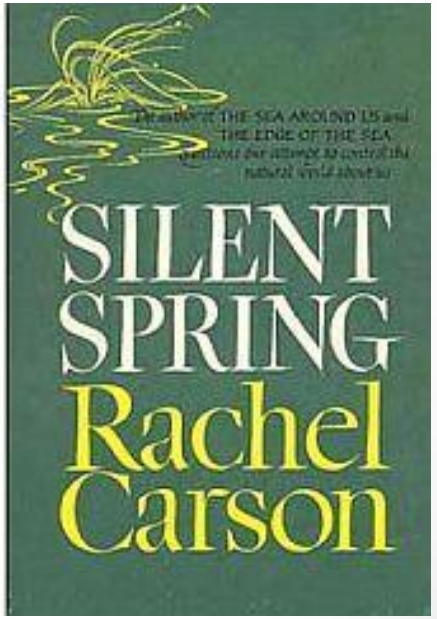
- The Dust Bowl was a period of severe dust storms that greatly damaged the ecology and agriculture of the American and Canadian prairies during the 1930s; severe drought and a failure to apply dryland farming methods to prevent wind erosion caused the phenomenon.



Requirement 1: Timeline

Silent Spring

- *Silent Spring* is an environmental science book by Rachel Carson. The book was published on September 27, 1962, documenting the adverse environmental effects caused by the indiscriminate use of pesticides, particularly DDT.



Requirement 1: Timeline

Cuyahoga River Fire 1969

- Fires were nothing out of the ordinary on Cleveland's Cuyahoga River in the 1960s.
- The river, which empties into Lake Erie, had long been a dumping place for sewage and industrial waste.
- On June 22, 1969, a spark from train tracks ignited industrial debris floating on the surface of the water.
- Flames spread across the river, in some places reaching five stories high.
- The river fire helped create an environmental revolution that culminated in the creation of the Environmental Protection Agency.

Requirement 1: Timeline

National Environmental Policy Act 1969

- National Environmental Policy Act (NEPA), the first major U.S. environmental law.
- Enacted in 1969 and signed into law in 1970 by President Richard M. Nixon.
- NEPA requires all federal agencies to go through a formal process before taking any action anticipated to have substantial impact on the environment.

Requirement 1: Timeline

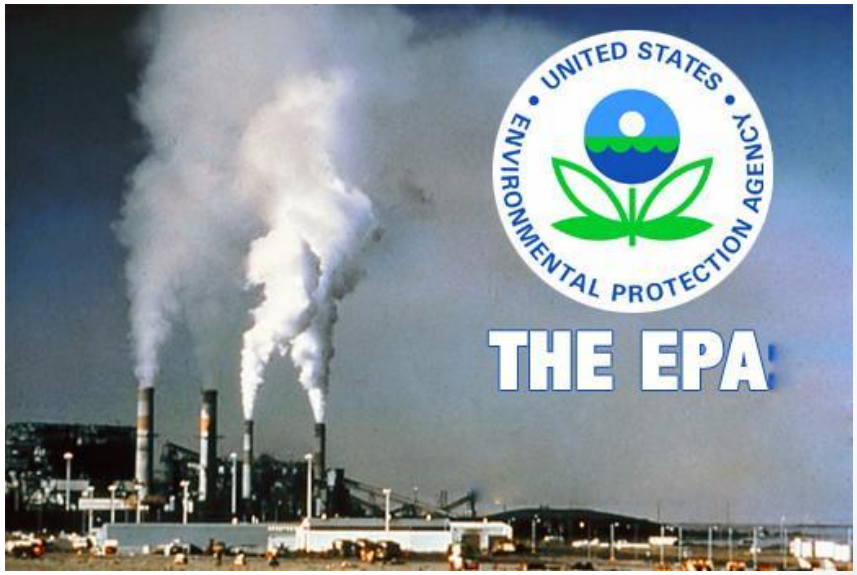
Clean Air Act 1970

- The Clean Air Act is a United States federal law designed to control air pollution on a national level.
- It is one of the United States' first and most influential modern environmental laws, and one of the most comprehensive air quality laws in the world.

Requirement 1: Timeline

EPA Established 1970

- Born in the wake of elevated concern about environmental pollution.
- EPA was established on December 2, 1970 to consolidate in one agency a variety of federal research, monitoring, standard-setting and enforcement activities to ensure environmental protection.



Requirement 1: Timeline

Earth Day 1970

- Earth Day was founded in 1970 as a day of education about environmental issues.
- The holiday is now a global celebration that's sometimes extended into Earth Week, a full seven days of events focused on green living.

Requirement 1: Timeline

Clean Water Act 1972

Then

Now

- The Clean Water Act is a U.S. federal law that regulates the discharge of pollutants into the nation's surface waters, including lakes, rivers, streams, wetlands, and coastal areas.
- Passed in 1972 and amended in 1977 and 1987, the Clean Water Act was originally known as the Federal Water Pollution Control Act.

Requirement 1: Timeline

Love Canal

- Love Canal is a neighborhood in Niagara Falls, New York, infamous as the location of a 70-acre landfill that became the site of a massive environmental disaster in the 1970s.
- During the 1940s the Hooker Chemical Company used the site to dump tons of chemical byproducts and eventually sold it to the local school district in 1953.
- It attracted national attention for the public health problem originating from the former dumping of toxic waste on the site that resulted in families with longstanding health issues and symptoms of leukemia.

Requirement 1: Timeline

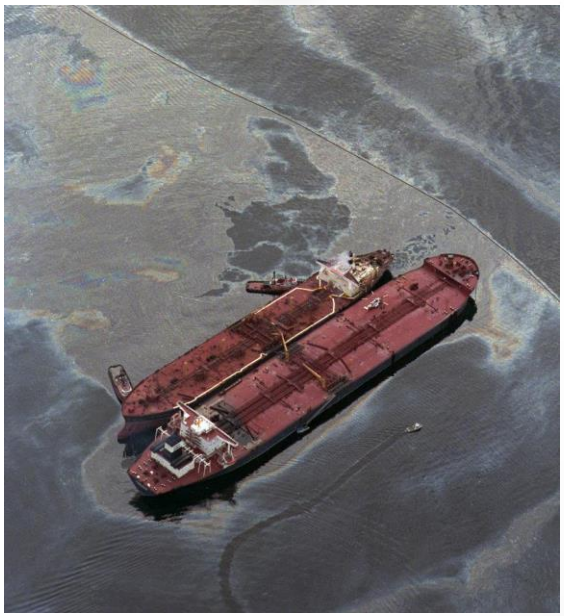
Love Canal

- The federal government passed the Superfund law in 1980 which was designed to investigate and clean up sites contaminated with hazardous substances.
- The resulting Superfund cleanup operation demolished the neighborhood, ending during 2004.

Requirement 1: Timeline

Exxon Valdez 1989

- The Exxon Valdez oil spill was a manmade disaster that occurred when Exxon Valdez, an oil tanker owned by the Exxon Shipping Company, spilled 11 million gallons of crude oil into Alaska's Prince William Sound on March 24, 1989.
- It was the worst oil spill in U.S. history until the Deepwater Horizon oil spill in 2010.

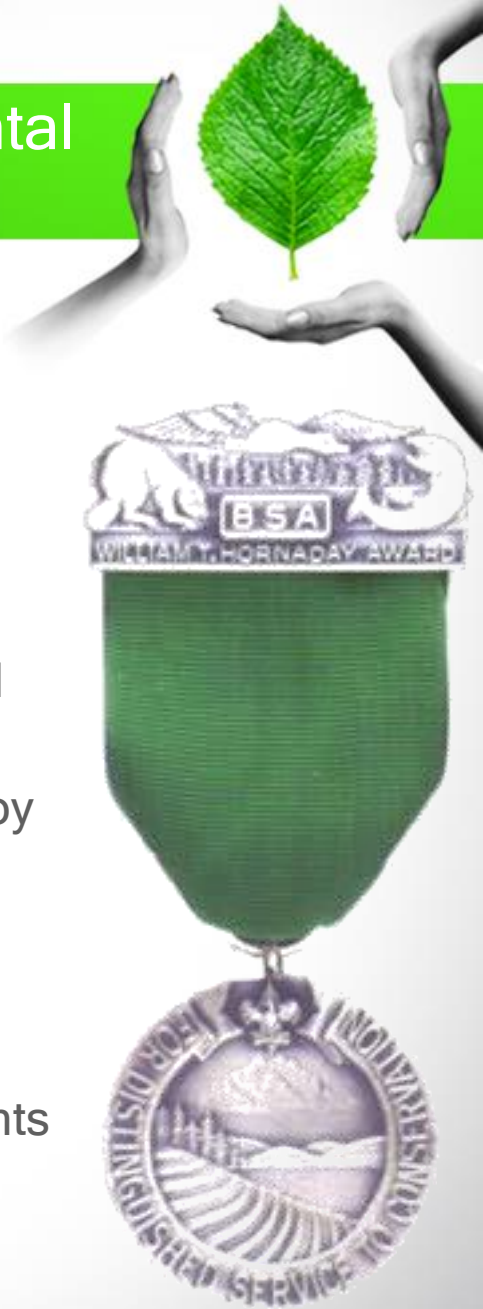


Requirement 1: Timeline

- The *Deepwater Horizon oil spill* is an industrial disaster that began on April 20, 2010, in the Gulf of Mexico on the BP-operated Macondo Prospect and is considered to be the largest marine oil spill in the history of the petroleum industry.

Requirement 1: BSA Contribution to Environmental Science

- 1902 – The Woodcraft Indians was started in Connecticut by the naturalist Ernes Thompson Seton to preserve the wilderness knowledge of American Indians.
- 1904 – William T. Hornaday authored legislation to protect migratory birds.
- 1905 – Daniel Carter Beard founded club called the Sons of Daniel Boone to teach boys about nature, conservation, and outdoorsmanship.
- 1910 – Seton and Beard merged their boys' clubs into the Boy Scouts of America. William D. Boyce founded this new organization.
- Many of the principles that Scouts uphold come from the conservation ethics of Seton and Beard.
- As of 2020, BSA has taught more than 110 million participants environmental principles.
- As of 2020, with more than 3.3 million participants, BSA continues to teach principles of conservation and environmental science.



Requirement 1: BSA Contribution to Environmental Science

Outdoor Code

As an American, I will do my best to -

- Be clean in my outdoor manners.
- Be careful with fire.
- Be considerate in the outdoors.
- Be conservation minded.

Requirement 1: BSA Contribution to Environmental Science

The Principles of Leave No Trace

1. Plan ahead and prepare.
2. Travel and camp on durable surfaces.
3. Dispose of waste properly (pack it in, pack it out).
4. Leave what you find.
5. Minimize campfire impacts.
6. Respect wildlife.
7. Be considerate of other visitors.

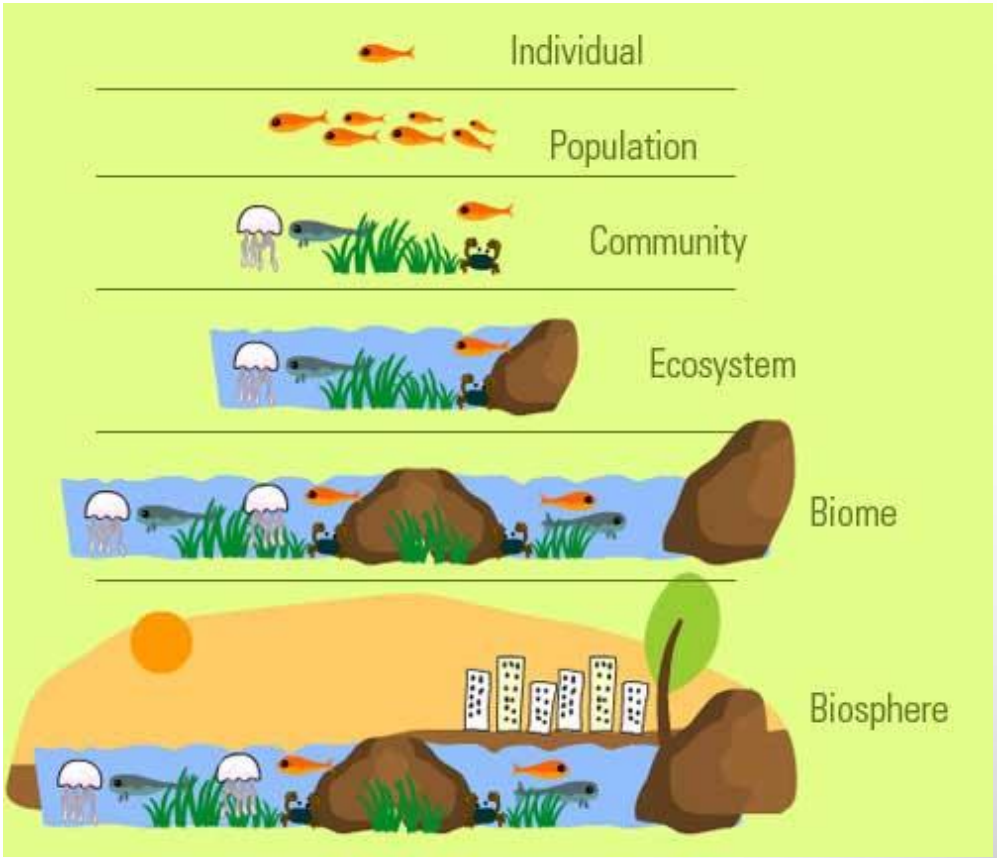
Requirement 2: Defining Terms

2. Define the following terms: population, community, ecosystem, biosphere, symbiosis, niche, habitat, conservation, threatened species, endangered species, extinction, pollution prevention, brownfield, ozone, watershed, airshed, nonpoint source, hybrid vehicle, fuel cell.

Requirement 2: Defining Terms

Environmental Science Terms

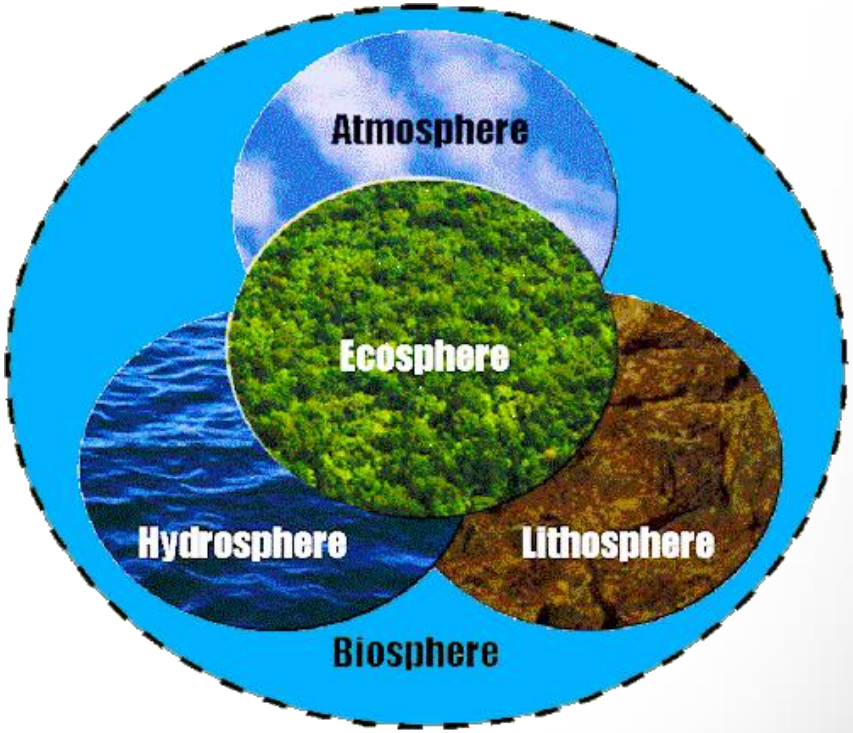
- *Population* -a group of the same organism in an area.
- *Community* -many populations living and interacting together.
- E*cosystem* -the interaction between all living and non-living things in an area.



Requirement 2: Defining Terms

Biosphere

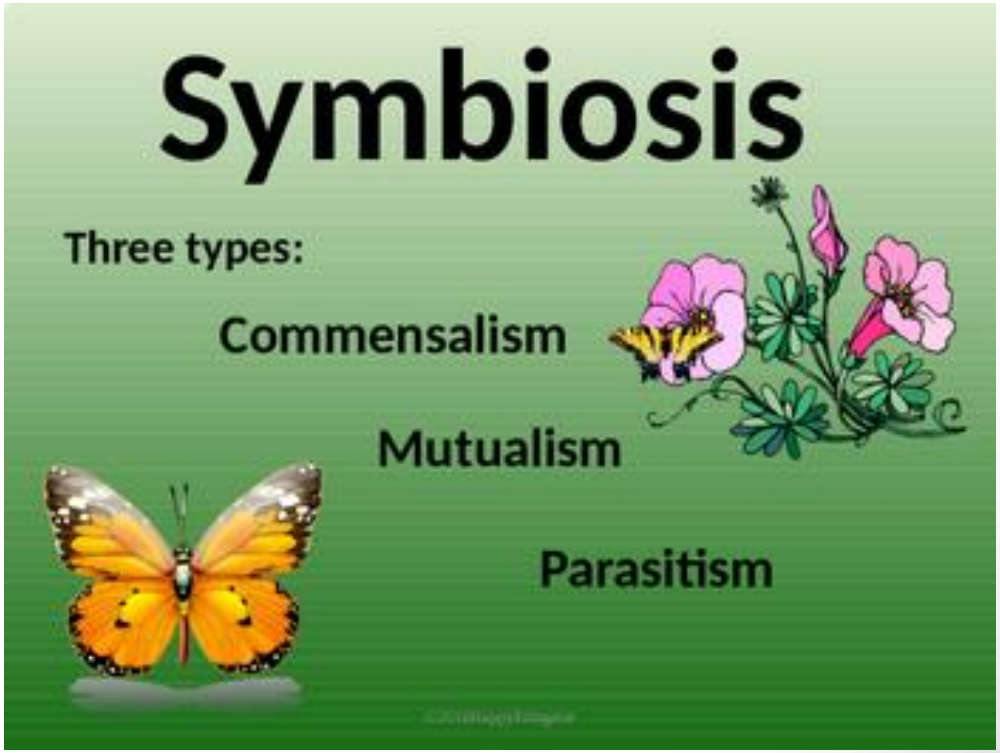
- Our living world where all trees, bugs, and animals live.
- The biosphere extends to any place that life (of any kind) can exist on Earth.



Requirement 2: Defining Terms

Symbiosis

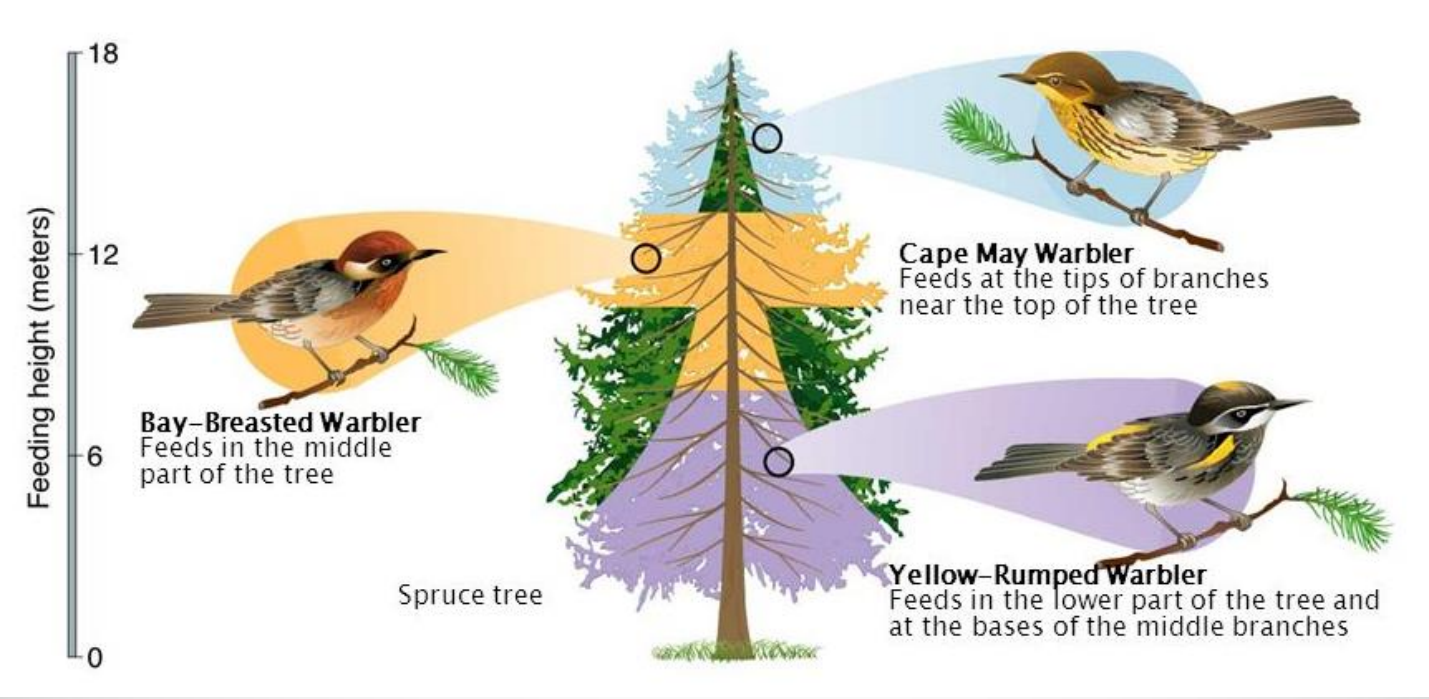
- A close and often long-term interaction between two or more different biological species.



Requirement 2: Defining Terms

Niche

- Defines an organism's role in an ecosystem. A *niche* may also encompass what the organism eats, how it interacts with other living (biotic) elements, and also how it interacts with the nonliving (abiotic) aspects of the environment, as well.



Requirement 2: Defining Terms

Habitat

- The natural home or environment of an animal, plant, or other organism.

Requirement 2: Defining Terms

Conservation

- Practices that protect animals, plants and the environment.

Requirement 2: Defining Terms

Threatened vs Endangered

- Threatened Species
  - Any species which are “likely” to become an endangered species within the foreseeable future.
- Endangered Species
  - A *species* in danger of “extinction” throughout all or a significant portion of its range.

Requirement 2: Defining Terms

Requirement 2: Defining Terms

Requirement 2: Defining Terms

Extinction is the termination of a species.

Requirement 2: Defining Terms

Pollution Prevention

- Activities that reduce the amount of pollution generated by a process, whether it is consumer consumption, driving, or industrial production

Requirement 2: Defining Terms

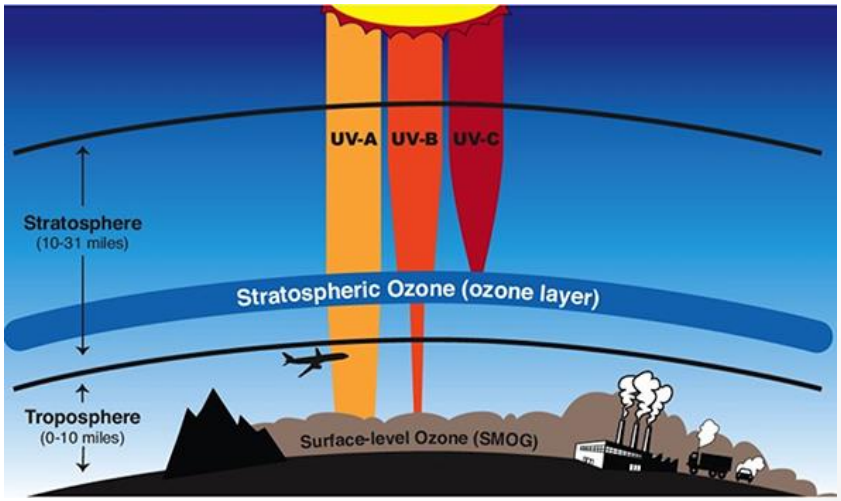
Brownfield

- *Brownfield* sites are abandoned or underused industrial and commercial facilities available for expansion, redevelopment, or reuse which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.

Requirement 2: Defining Terms

Ozone

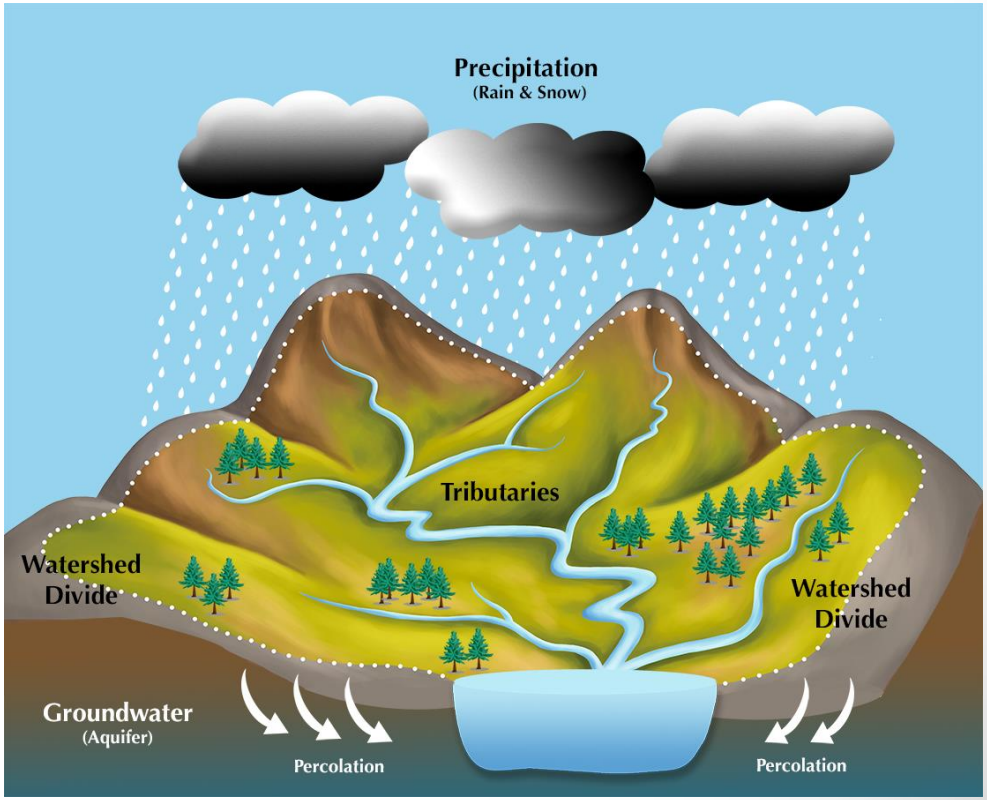
- Atmospheric Ozone is produced when ultraviolet radiation interacts in the stratosphere.
- Ozone in the atmosphere is naturally produced and destroyed at a constant rate.
- Ozone protects the earth from harmful UV radiation which damages skin, eyes, and the immune system of life forms.
- Ozone makes life on earth possible.
- Ground-level Ozone is a major pollutant and green house gas.



Requirement 2: Defining Terms

Watershed

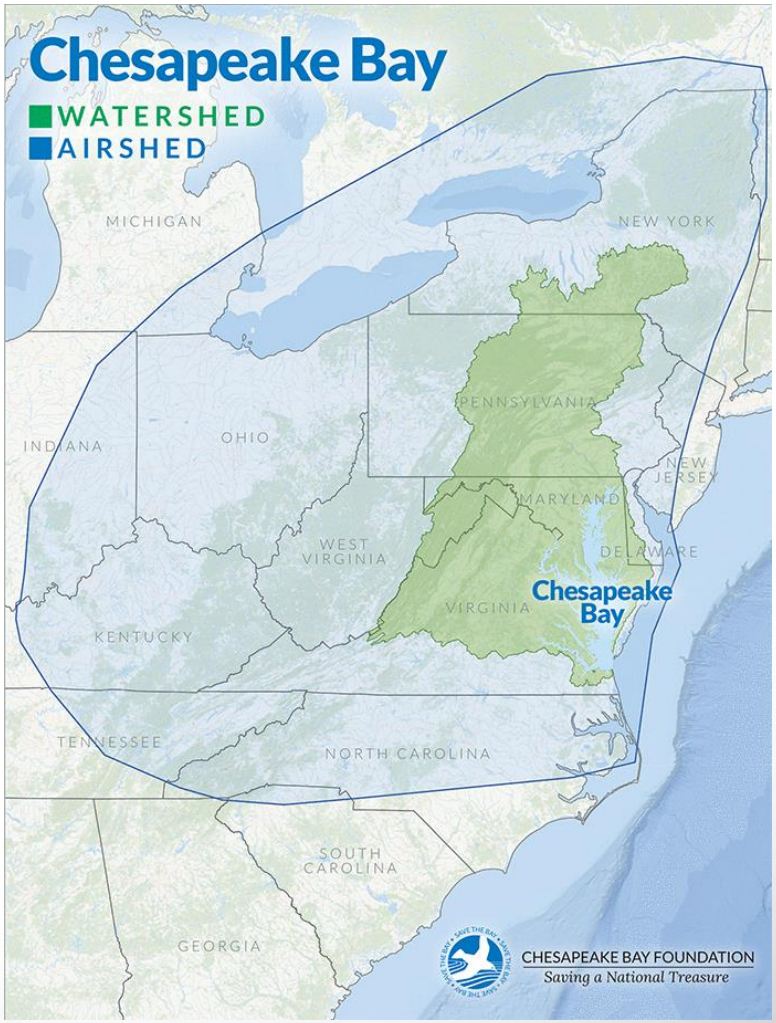
- A watershed is the area of land where all of the water that is under it or drains off of it goes into the same place.



Requirement 2: Defining Terms

Airshed

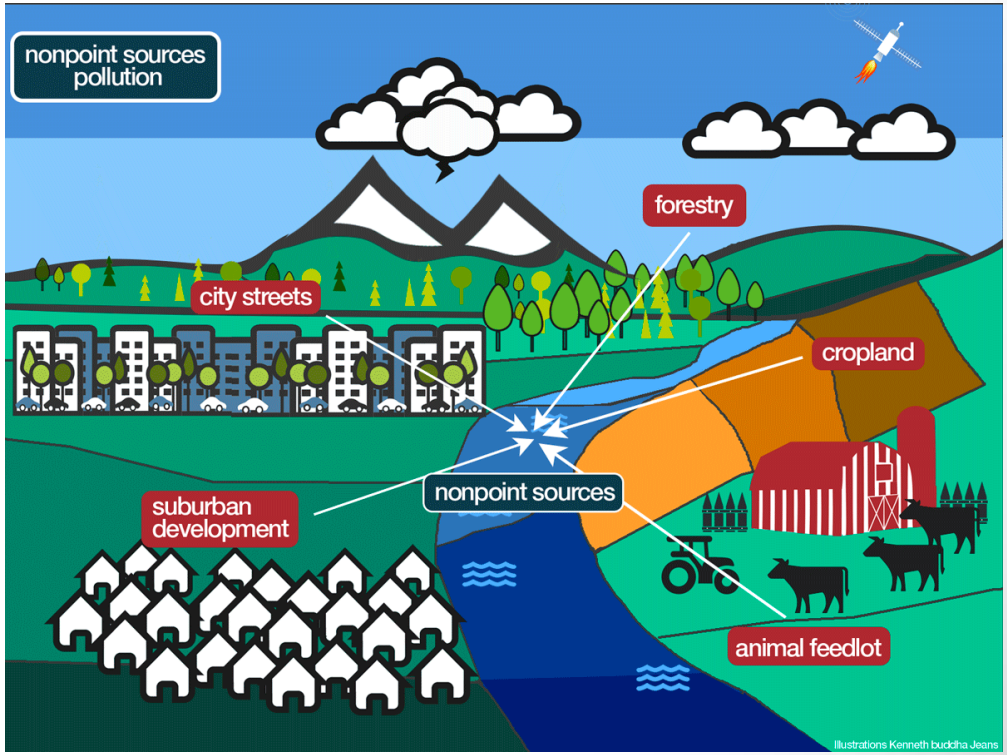
- An airshed can be compared to a watershed. an airshed is a geographic area where air pollutants from sources "upstream" or within the area flow and are present in the air.



Requirement 2: Defining Terms

Nonpoint source pollution

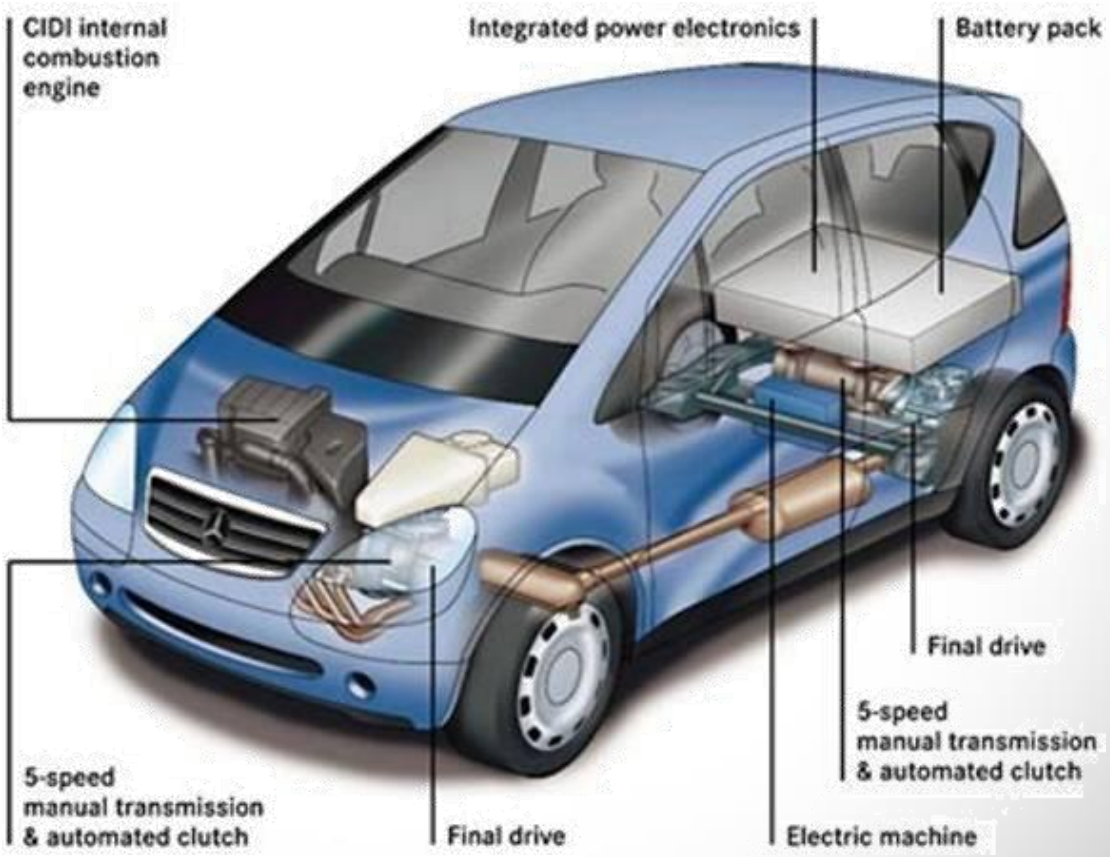
- *Nonpoint source* (NPS) is a source of pollution, discharged over a wide land area, not from one specific location such as a pipe discharge.
- Example: rainwater runoff



Requirement 2: Defining Terms

Hybrid vehicle

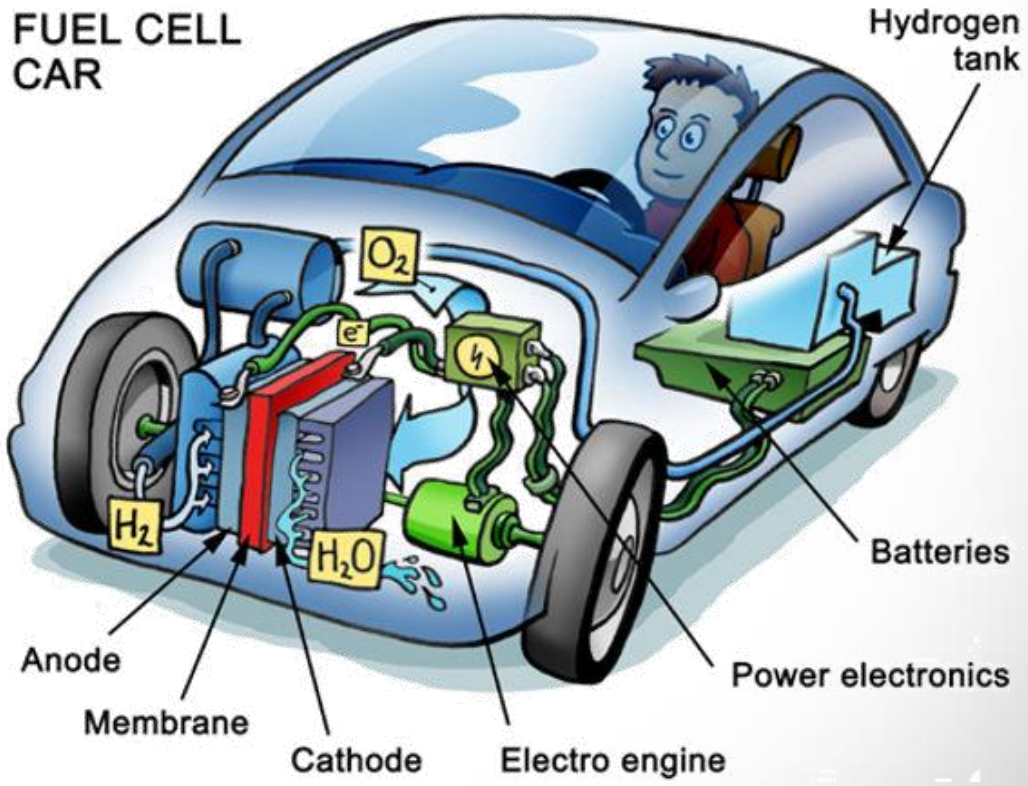
- A vehicle that uses two or more distinct power sources to move the vehicle.



Requirement 2: Defining Terms

Fuel cell

- A device that converts the chemical energy from a fuel into electricity through a chemical reaction with oxygen or another oxidizing agent.



Requirement 3a

3. Do ONE activity from seven of the following categories (using the activities in the merit badge pamphlet as the basis 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.
      3. Discuss what is an ecosystem. Tell how it is maintained in nature and how it survives.

Requirement 3a1

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

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.

Procedure

Step 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.

Step 2 – Place a lamp next to the middle of the shoebox, close enough that it shines on the uncovered part of the box.

Step 3 – Place 10 earthworms on the centerline of the bottom of the box so that the worms are half in the dark and half in the light.

Step 4 – Observe the worms for five minutes. Note their behavior in a notebook.

Step 5 – When your experiment is over, take the worms outside and return them to the soil.

Requirement 3a1

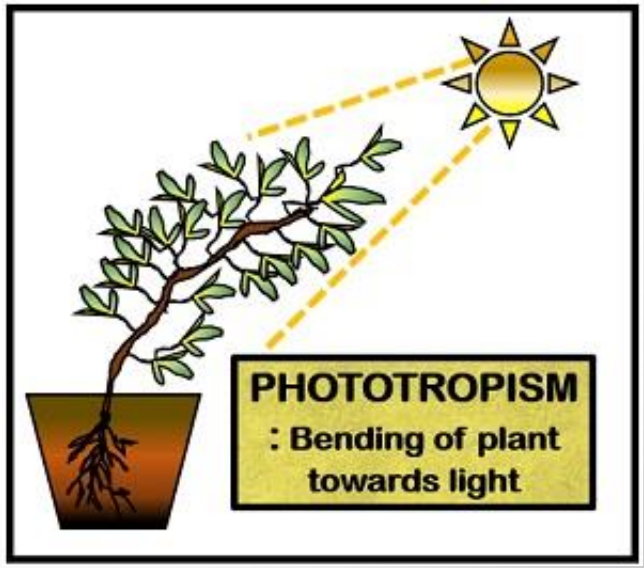
Conduct an experiment to find out how living things respond to changes in their environments. Record your observations and conclusions in a notebook and discuss with your counselor.

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 box? In the shaded part of the box?
3. What nonliving environment 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?



Requirement 3a2

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

The Greenhouse Effect

This activity demonstrates how the atmosphere traps the sun's energy to warm the Earth's surface.

Procedure

Step 1 – Using scissors, cut the tops off of two clear 2-liter soda bottles. Make your cut about 4 inches from the top. Label on bottle "A" and the other bottle "B".

Step 2 – Pour 2 cups of garden soil or potting soil into each bottle.

Step 3 – Place a thermometer inside each bottle. Make sure the thermometers are placed at the same distance above the soil in each bottle.

Step 4 – Cover the top of bottle B with clear plastic wrap and secure it with a rubber band or tape.

Requirement 3a2

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

The Greenhouse Effect (continued)

Procedure

Step 5 – Place a lamp on a table, removing the lampshade to expose the lightbulb. Position each bottle exactly 1 inch from the exposed bulb. Be sure to turn the bottles so that the thermometers face away from the lightbulb. You may need to shade the thermometers from direct light to get accurate readings of air temperatures.

Step 6 – With the light off, record the temperature in each bottle in your notebook.

Step 7 – Turn on the lamp.

Step 8 – Using a watch, wait three minutes, and then record the temperatures again. Record the temperatures in each bottle every three minutes for 15 minutes.

Requirement 3a2

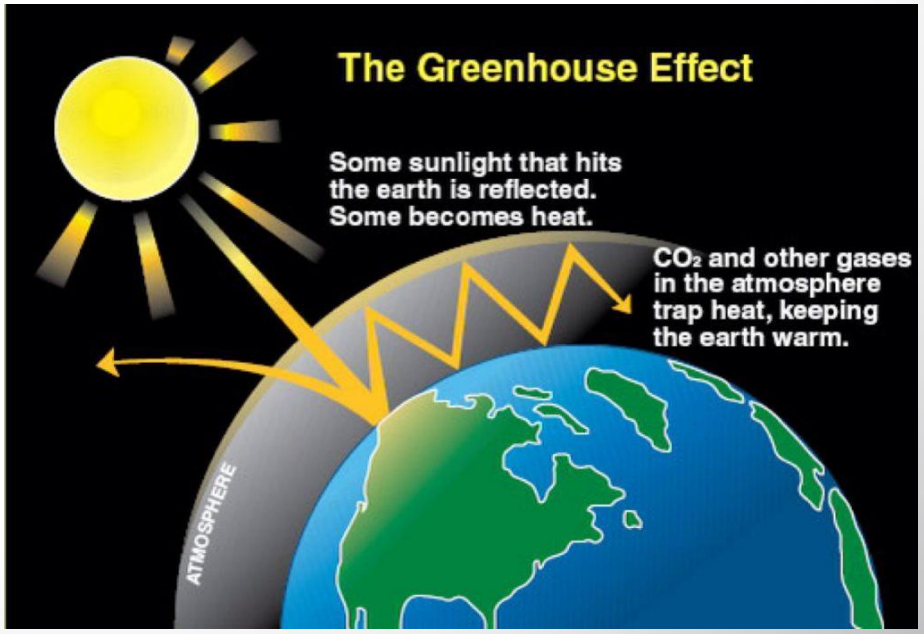
Conduct an experiment illustrating the greenhouse effect. Keep a journal of your data, observations, and conclusions. Discuss your conclusions with your counselor.

Observations

1. Did the temperature in each bottle change during your experiment?
2. Explain what the lightbulb and the plastic wrap represent in this model of the greenhouse effect.

Conclusions

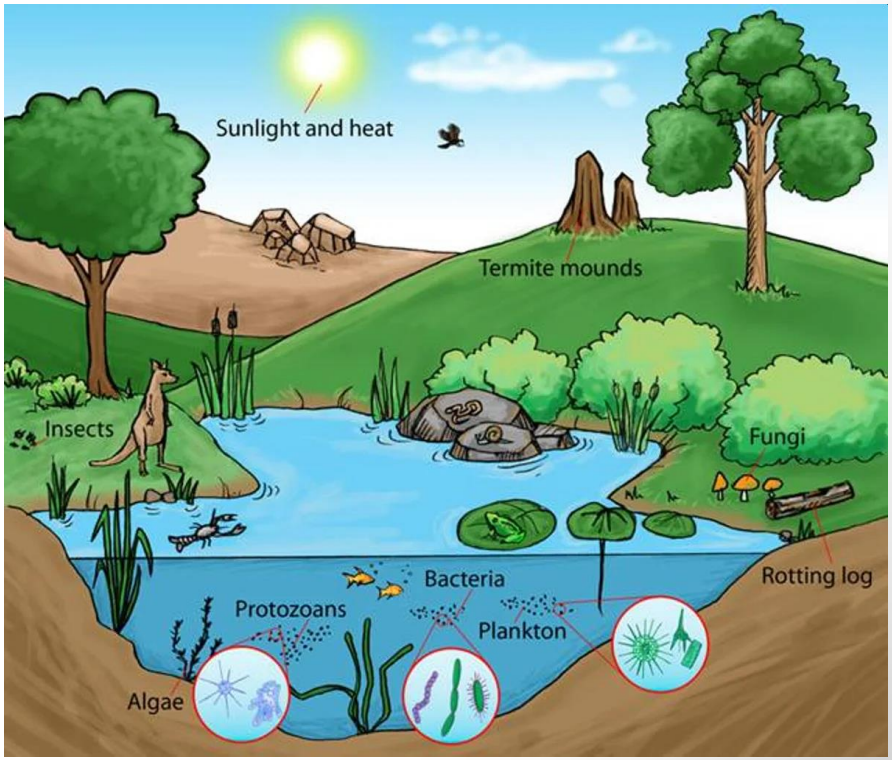
Compare your experimental setup to real conditions on Earth. Using your data, explain why the greenhouse effect makes it possible for life to exist on Earth.



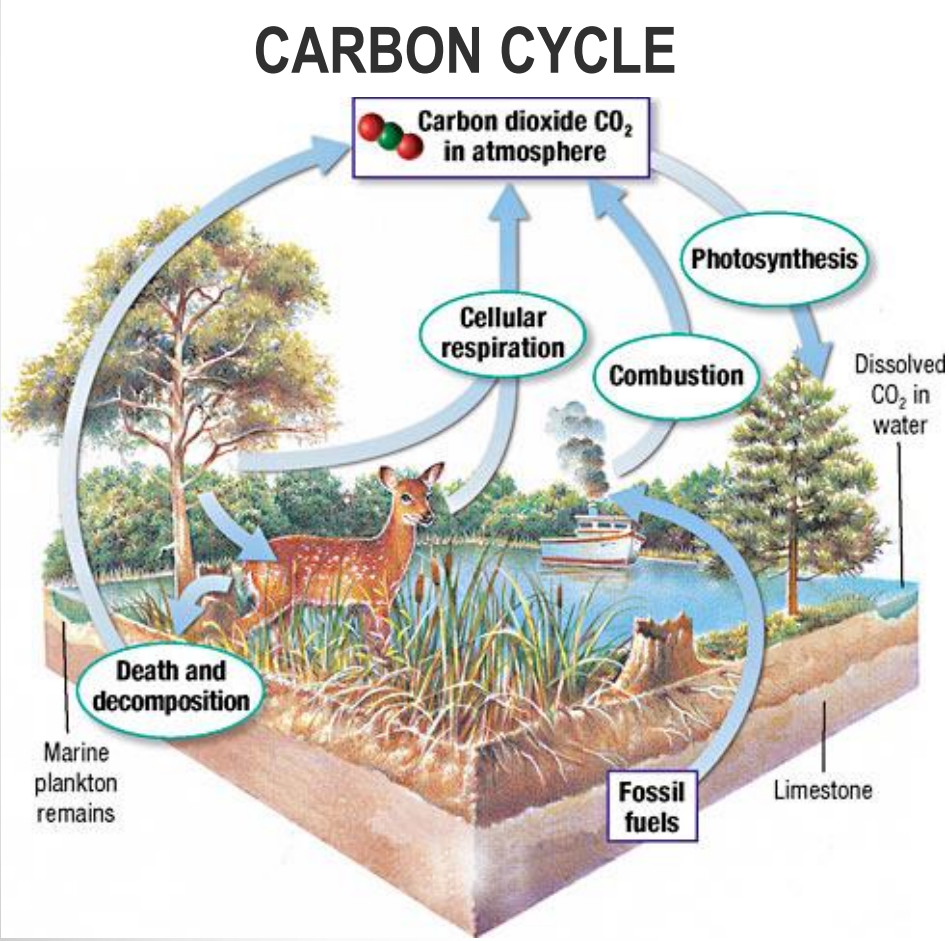
Requirement 3a3

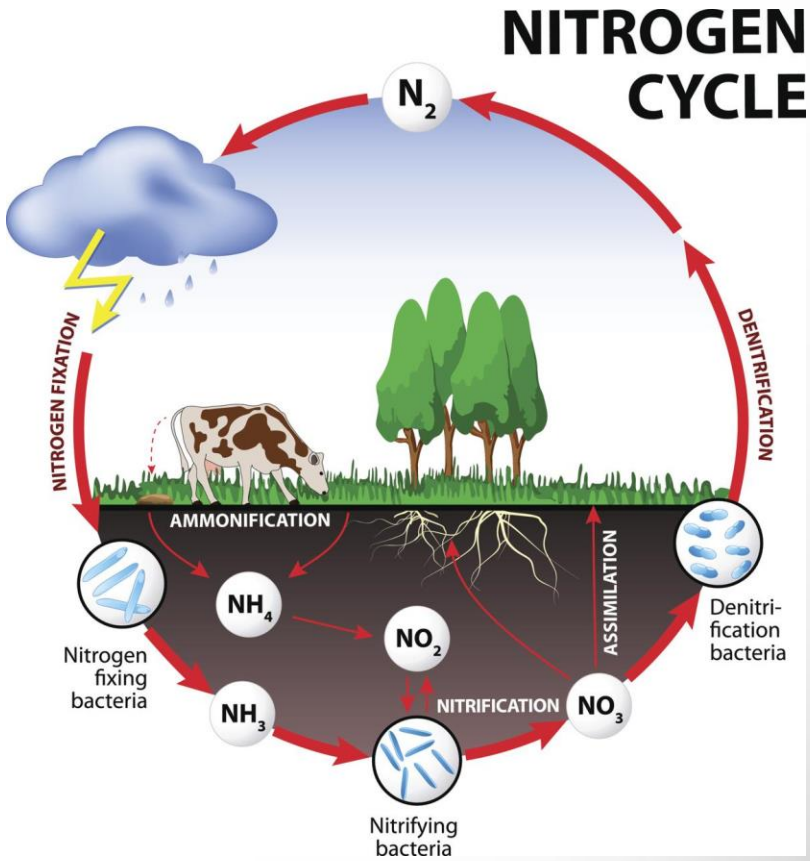
Discuss what is an ecosystem. Tell how it is maintained in nature and how it survives.

- An **ecosystem** is a community of living organisms in conjunction with the nonliving components of their environment, interacting as a system. These biotic and abiotic components are linked together through nutrient cycles and energy flows.



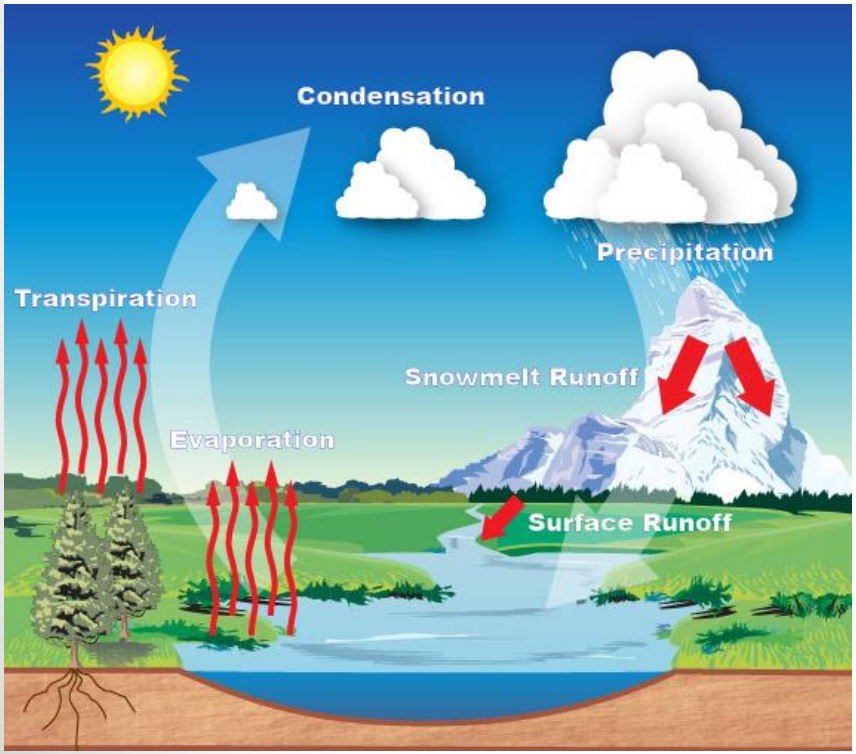
Requirement 3a3



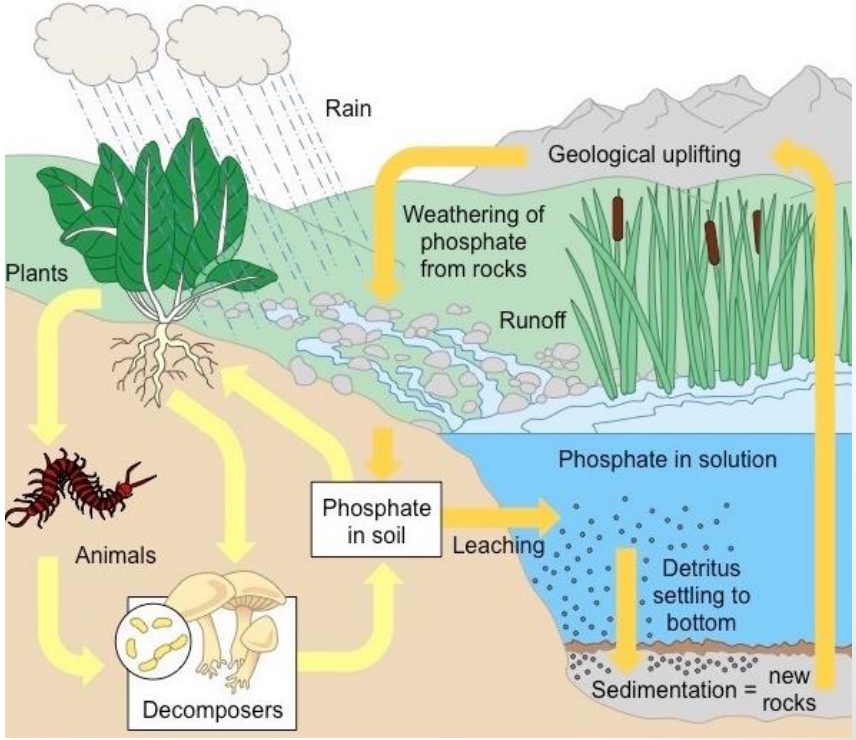


Requirement 3a3

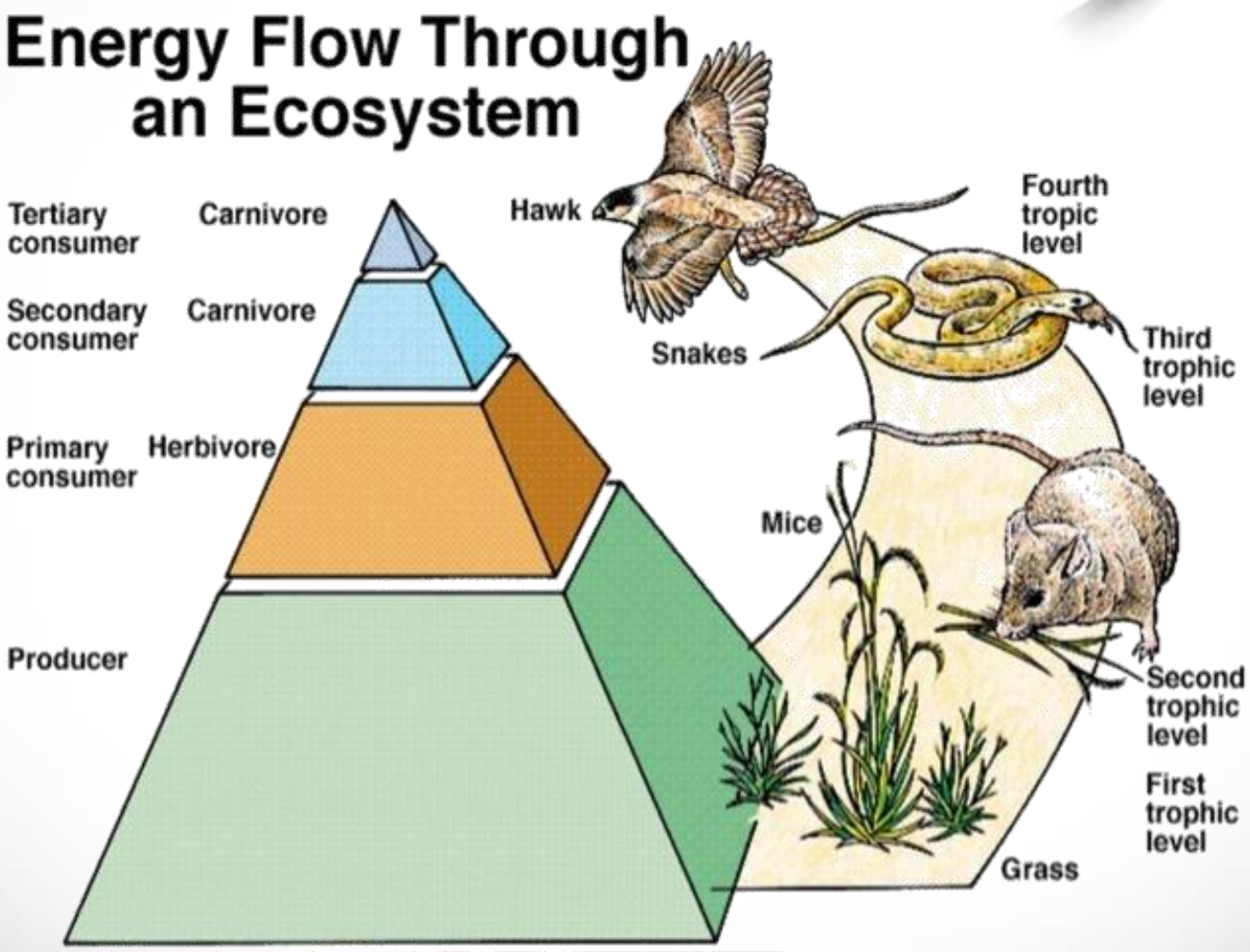
WATER CYCLE



PHOSPHORUS CYCLE



Requirement 3a3



Requirement 3b

3. Do ONE activity from seven of the following categories (using the activities in the merit badge pamphlet as the basis for planning and carrying out your projects):

b. Air Pollution

1. Perform an experiment to test for particulates that contribute to air pollution. Discuss your findings with your counselor.
2. Record the trips taken, mileage, and fuel consumption of a family car for seven days, and calculate how many miles per gallon the car gets. Determine whether any trips could have been combined ('chained') rather than taken out and back. Using the idea of trip chaining, determine how many miles and gallons of gas could have been saved in those seven days.
3. Explain what is acid rain. In your explanation, tell how it affects plants and the environment and the steps society can take to help reduce its effects.

Requirement 3b1

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

Air Pollution

In this experiment, you will observe some of the particulates that pollute air.

Procedure

Step 1 – Spread a thin film of petroleum jelly on two paper plates or two 3 by 5 inch index cards. These will serve as your air pollution collectors.

Step 2 – Place one collector in an urban environment, such as near a busy street. Place the other collector in a nonurban environment, such as in a field or a forested area.

Step 3 – Protect each collector from precipitation by placing a cover above it or placing it underneath an overhanging roof or tree limb.

Step 4 – Leave both collectors in place for one week.

Requirement 3b1

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

Air Pollution (continued)

Procedure

Step 5 – Retrieve the collectors. Using a magnifying glass, look at the surface of each collector to identify any particulates.

Step 6 – Place a sheet of clear plastic, marked off in a grid of 1 inch squares, over one collector. Using the magnifying glass, count the number of particulates in four of the squares. Find the average number of particulates in a square and record this number.

Step 7 – Repeat step 6 for the other collector.

Requirement 3b1

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

Observations

1. What was the average number of particulates on the collector left in an urban environment? In the nonurban environment?
2. What do the particulates on the two collectors suggest about the level of particulate pollution in each environment?

Conclusions

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

Requirement 3b2

Trip Log

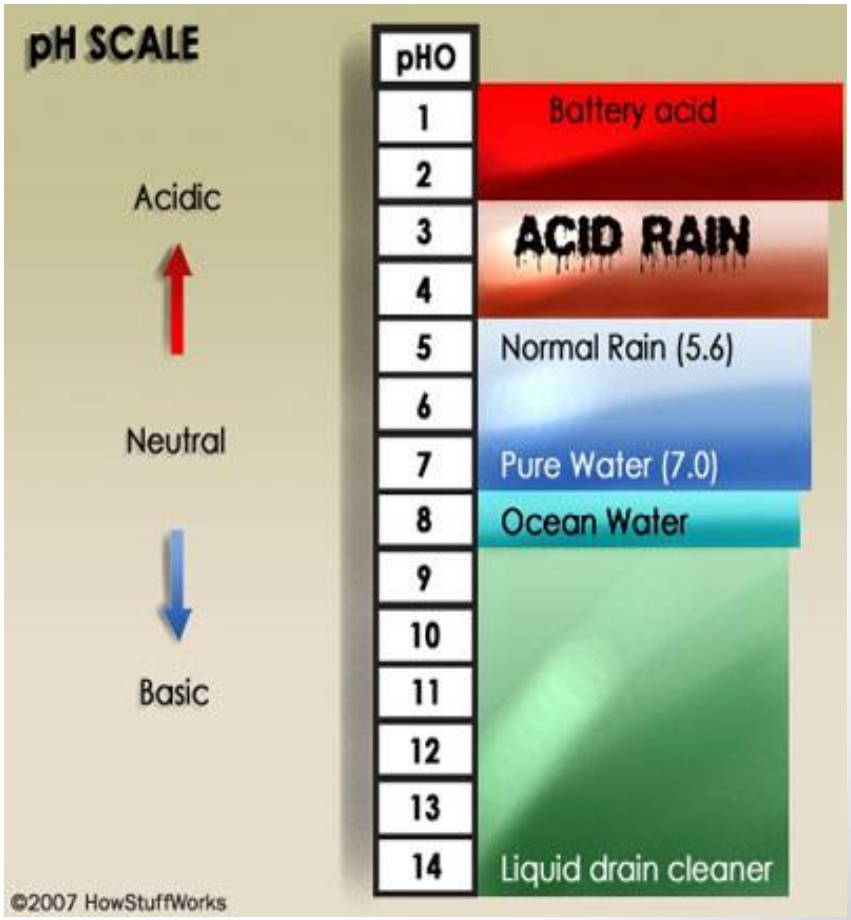
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Trip 1 Location							
Trip 2 Location							
Trip 3 Location							
Trip 4 Location							
Trip 5 Location							
Total Mileage							
Fuel used							
MPG							

Determine whether any trips could have been combined ('chained') rather than taken out and back. Using the idea of trip chaining, determine how many miles and gallons of gas could have been saved in those seven days.

Requirement 3b3

What is acid rain?

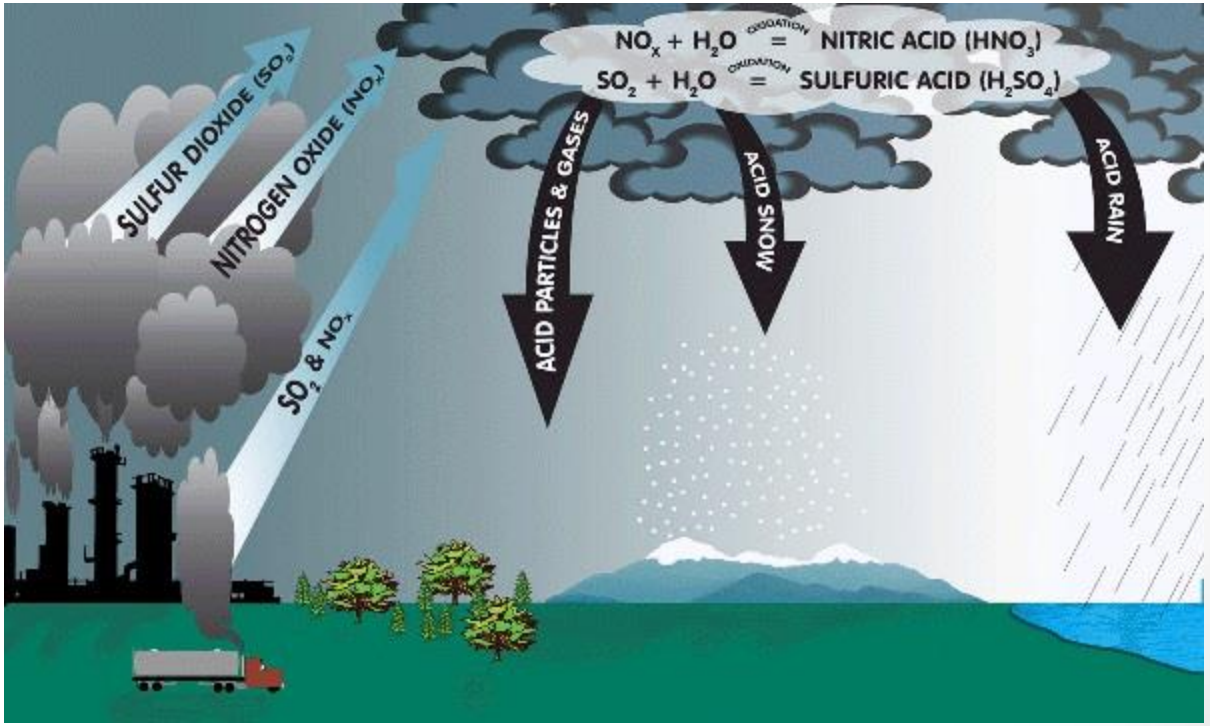
- Acidity is a property measured on a scale called the pH scale with a range of 0 to 14.
- Pure water has a pH of 7.
- Rain is naturally slightly acidic, with a pH of about 5.6, this is because carbon dioxide in the atmosphere reacts with water vapor to become carbonic acid.



Requirement 3b3

What is acid rain?

- Sulfur dioxide and nitrogen oxides are the primary causes of acid rain.
- When vehicles and power plants that burn fossil fuels emit sulfur dioxide and nitrogen oxides into the air, these gases interact with water vapor to form sulfuric and nitric acids.
- These acids then mix with rain and fall to Earth's surface as acid rain.



Acid rain can deplete the soil of the nutrients that plants need to grow. When acid rain falls, it filters down through the soil and dissolves soil nutrients and other materials, moving them down to layers out of reach of plant roots.

Requirement 3b3

How acid rain effects the environment.

Plants and Trees

- Reduces crop production, damage to seeds.
- Reduces quality of crops.
- Plants may die from acid rain or be weakened so that they are more easily harmed by other kinds of stresses in the environment, such as cold temperatures, insect damage, or droughts.

Aquatic Ecosystems

- Acid rain damages aquatic ecosystems by changing the pH of the water and depleting nutrients.
- Many aquatic organisms may die when acid rain falls into lakes and ponds.
- Affects marine food chain; damage to fisheries result.

Materials

- Corrosion of metals (such as bronze) and the deterioration of paint and stone (such as marble and limestone).
- These effects significantly reduce the societal value of buildings, bridges, cultural objects (such as statues, monuments, and tombstones), and cars.

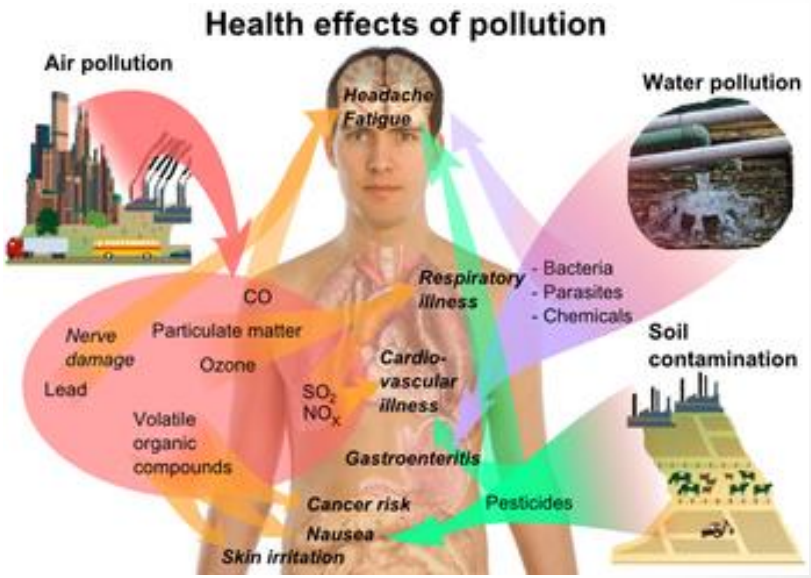
Requirement 3b3

How acid rain effects the environment.

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.

Requirement 3b3

How acid rain affects the environment.



Requirement 3b3

Steps society can take to help reduce the effects of acid rain.

- Clean combustion technologies
- Using pollution control equipment.
- Replacement of coal by natural gas or renewable energy resources.
- Liming of lakes and soils.
- Adopt policies for reduction of sulfur dioxide and other acid rain causing gas emissions.
- Support projects that promote cleaner production by reducing air pollution to improve the environment.

Liming of a Lake in New England

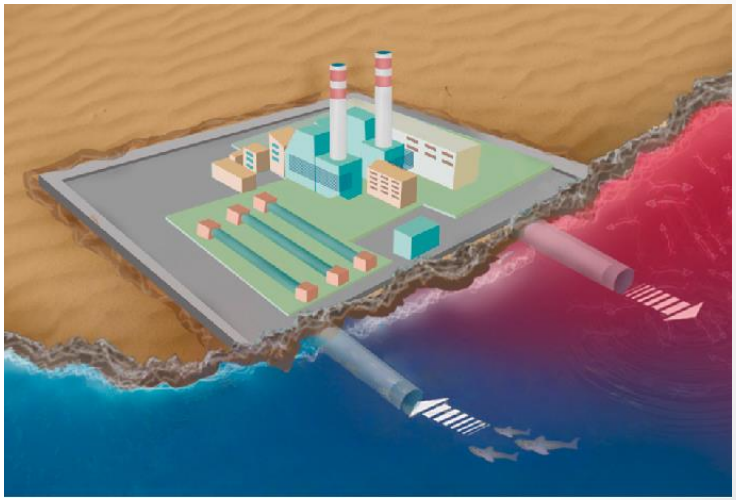
Requirement 3c

3. Do ONE activity from seven of the following categories (using the activities in the merit badge pamphlet as the basis for planning and carrying out your projects):
   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.
      3. Describe the impact of a waterborne pollutant on an aquatic community. Write a 100-word report on how that pollutant affected aquatic life, what the effect was, and whether the effect is linked to biomagnification.

Requirement 3c1

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

Thermal Pollution of Water



Recall that thermal pollution occurs when a source of heat raises air or water temperature above normal. The normal temperature ranges for our lakes and river are: above 68 degrees for warm water where most bass like to live: between 68 and 55 degrees for moderate water where salmon like to live; and below 55 degrees for cold water where most trout like to live. In this experiment you will discover if algae are sensitive to thermal pollution.

Procedure

Step 1 – Set up two 10 gallon aquarium tanks or other clear large containers. Place one of them in a location where it will not get above 60 degrees. Fill them both with tap water. Be very careful if you attempt to move a tank after you have filled it with water..

Step 2 – Place a thermometer in each tank and add a heat source (aquarium heater, external lightbulb, or direct sunlight) to one of the tanks. This tank should be raised to a temperature over 70 degrees.

Requirement 3c1

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

Thermal Pollution of Water (continued)

Procedure

Step 3 – Feed each of the tanks with enough fish food or liquid plant fertilizer to feed several fish or plants in the tanks. Record the date, time, and temperature of each tank in your notebook.

Step 4 – Repeat step three several times each day for the next seven days. In addition to the above information, also record any presence of algae growing in the sides of the tank in your notebook. Describe the algae and make a sketch or take pictures to show the growth of the algae.

Step 5 – At the end of the experiment be sure to clean the containers and remove the algae buildup.

Requirement 3c1

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

Observations

1. Why did you feed the water in both tanks at the beginning and throughout the experiment? Why not just feed the heated tanks?
2. What was the difference in temperature of the two tanks? What activities would increase the temperature of a river or lake near you by this much?
3. Did you notice any change (color, appearance, pattern, etc.) in the algae during the experiment? What do you think might have caused this?

Conclusions

Using your data, explain how thermal pollution may affect aquatic organisms. Recall what you learned about how fertilizer can promote algae blooms. Why is increased growth of algae bad for an aquatic environment? How would thermal pollution affect fish, water plants, or other organisms that cannot escape from the source of the heat? Can you speculate about the effects of thermal pollution in the air?

Requirement 3c2

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.

Cleaning Up Oil Spills

When an oil spill occurs in an aquatic environment, the first step in the cleanup process is trying to control the oil and keep it from spreading to coastal areas where it would affect many wildlife species. Waterfowl are especially vulnerable to oil spills. The oil coats the birds' feathers, causing their feathers to clump together and lose the ability to keep the birds insulated from the cold. Oil-soaked birds often freeze to death. Others die after consuming the toxins from the oil as they attempt to rid their feathers of the oil. At least a half million waterfowl die each year as a result of oil spills. In this experiment you can examine several methods that are used to clean up oil spills at sea and speculate upon which methods might work best to reduce the effects of the spill on waterfowl.

Requirement 3c2

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.

Cleaning Up Oil Spills

Procedure

Step 1 – Label four aluminum pie pans “A,” “B,” “C,” and “D.”

Step 2 – Using a measuring cup, pour 1 cup of tap water into each pie plate.

Step 3 – Measure 4 tablespoons of vegetable oil. Add 1 tablespoon of vegetable oil to the water in each pie plate.

Step 4 – In Pan A, 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. Be careful not to touch the water with the straw.

Step 5 – In pan B, stir the oil and use a piece of string to try to collect the oil and contain it in one area.

Step 6 – Stir the oil in pan C. 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. Record and compare how well each material worked.

Step 7 – Stir the oil in pan D, then add 1 teaspoon of liquid dishwashing detergent to the water in the pan.

Requirement 3c2

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.

Observations

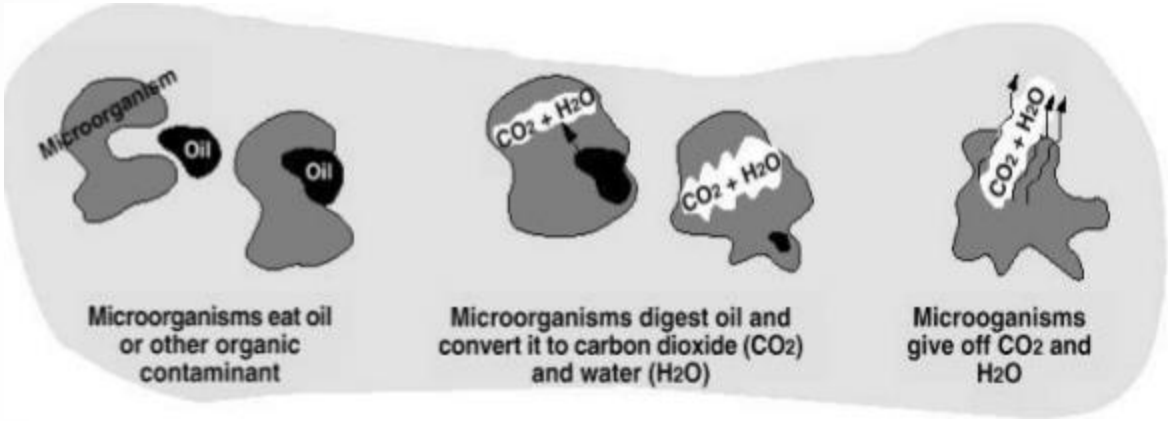
1. What happened to the oil and the water when you used a straw to blow the oil away? What conditions at sea might this represent that would make cleaning an oil spill more difficult?
2. How well did the string work to contain the oil in pan B?
3. Which of the materials used in pan C worked best to absorb the oil?
4. What happened when you added liquid dishwashing detergent to pan D? Can you explain why?

Conclusions

Scientists have developed 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 be practical in an actual spill at sea? Consider how cleanup methods might affect waterfowl and other organisms. Is a treatment better or worse for them than the effects of the spill itself? Compare the methods you used with the methods in real life explained in the next seven slides.

Requirement 3c2

Methods of Oil-Spill Cleanup

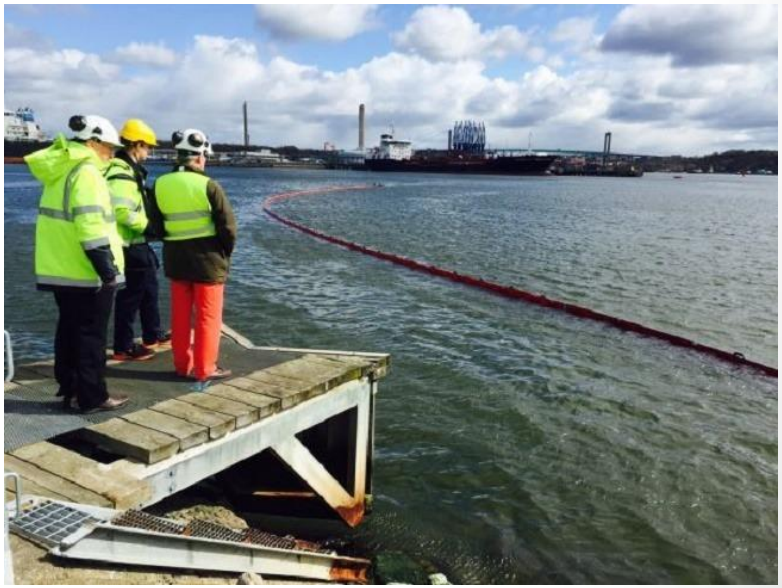


- **Bioremediation** is the use of microorganisms, fungi or bacteria, to decompose pollutants into simpler compounds.
- Microbes break down the different substances into water, carbon dioxide, and other compounds.
- It is may be augmented by using fertilizers to increase the population of oil-eating microbes.
- Bioremediation is a cost effective alternative but is a very slow process, sometimes taking weeks to months for results.

Requirement 3c2

Methods of Oil-Spill Cleanup

- **Oil Booms -** The use of oil booms is a very simple and popular method of controlling oil spills.
  - Equipment called containment booms acts like a fence to prevent the oil from further spreading or floating away.
  - Booms float on the water surface.
  - Connected sections of the boom are placed around the area of the oil spill until it is totally surrounded and contained.
- This method is effective only when the oil is in one spot.
- It works when the spill is accessible within a few hours of taking place, otherwise, the area of the spill becomes too large to manage.
- It cannot be successfully employed under rough sea waves, high wind velocities or fluctuating tides.



Requirement 3c2

Methods of Oil-Spill Cleanup

- **Chemical Dispersants -** When the spilled oil cannot be contained by using booms, the only option left is to accelerate the disintegration of oil.
  - Dispersal agents are chemicals that are sprayed upon the spill with the help of aircraft and boats, which aid the natural breakdown of oil components.
  - They allow the oil to chemically bond with water by increasing the surface area of each molecule. This ensures that the slick does not travel over the surface of the water, and is easier to degrade by microbes.
- It can effectively be used for spills over large areas.
- Use of dispersants can create tarballs. As the oil combines with water, it also gets mixed with sand and debris present in the water. This results in the formation of large tar balls floating on the surface of the water, which often find their way to the shores.
- The toxicity of dispersants can affect marine organisms, especially the non-mobile ones such as corals and seagrass.

Requirement 3c2

Methods of Oil-Spill Cleanup

- **Hot Water Washing -** This procedure is mainly used in situations where the oil is inaccessible to methods of mechanical removal such as using booms and skimmers. It is used to dislodge the trapped and weathered oil from locations which are generally inaccessible to machinery.
  - Water heaters are used to heat up water to around 170°C, which is then sprayed by hand with high-pressure wands or nozzles. The oil is thus flushed to the water surface, which can be collected with skimmers or sorbents.
- The released oil must be immediately and adequately recovered to prevent any further contamination.
- Organisms in the direct spray zone are “cooked” by the hot water leaving beaches sterile.

Requirement 3c2

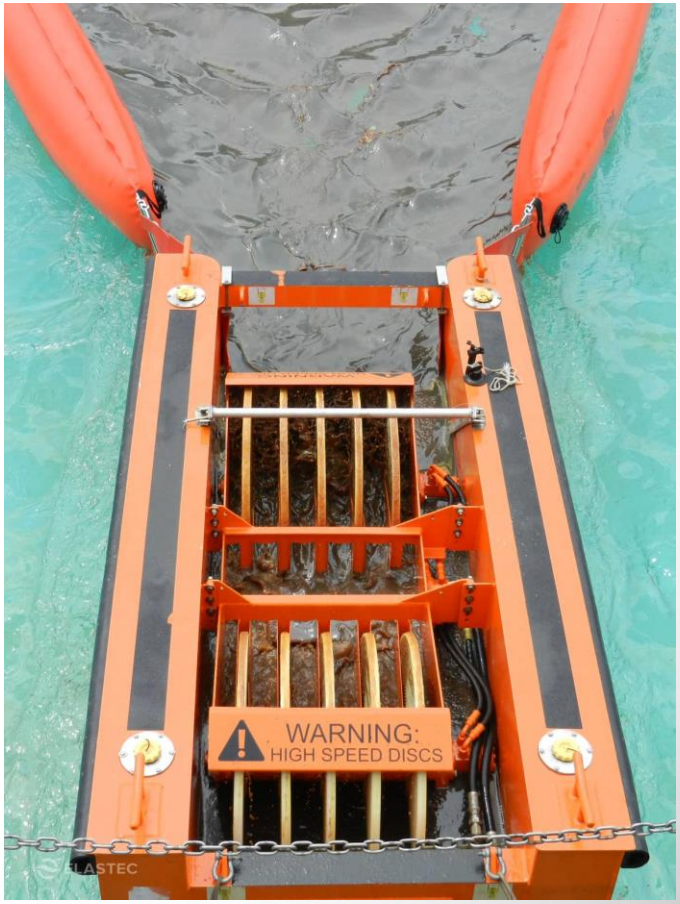
Methods of Oil-Spill Cleanup

- **Burning In-situ -** In this method, the oil floating on the surface is ignited to burn it off.
- Burning of oil can effectively remove up to 98% of an oil spill, which is more than most of the other methods.
- The toxic fumes released from the burning can cause significant damage to the environment as well as marine life.
- The procedure works on spills that are relatively fresh before the oil spreads to a larger area and decreases in thickness.

Requirement 3c2

Methods of Oil-Spill Cleanup

- **Skimmers -** Once the oil has been confined by using oil booms, skimmers or oil scoops can be deployed onto boats to remove the contaminants from the water surface.
  - Skimmers are machines specially designed to suck up the oil from the water surface like a vacuum cleaner.
  - They are used to physically separate the oil from the water so that it can be collected and processed for re-use.
- Skimmers can be used to effectively recover most of the spilt oil, so it is economically viable.
- The presence of debris poses a major roadblock to this technique, as skimmers can get clogged easily.



Requirement 3c2

Methods of Oil-Spill Cleanup

- **Sorbents -** Sorbents are materials that soak up liquids by either absorption (pulling in through pores) or adsorption (forming a layer on the surface).
  - Both these properties make the process of clean-up much easier.
  - Materials commonly used as oil sorbents are engineered polymers, peat moss, straw or vermiculite.
- The oil can be recovered, and this prevents wastage and further pollution.
- After the absorption, the sorbent materials must be retrieved which is a difficult task and may prove to be worse if ignored.
- Sorbents after absorption become heavier (3 to 15 times their weight), and as a result, may sink, making them difficult to retrieve and also pose a risk to aquatic life in the sea bottom.
- They are most effective in small spills or to manage the leftover traces of a larger spill.

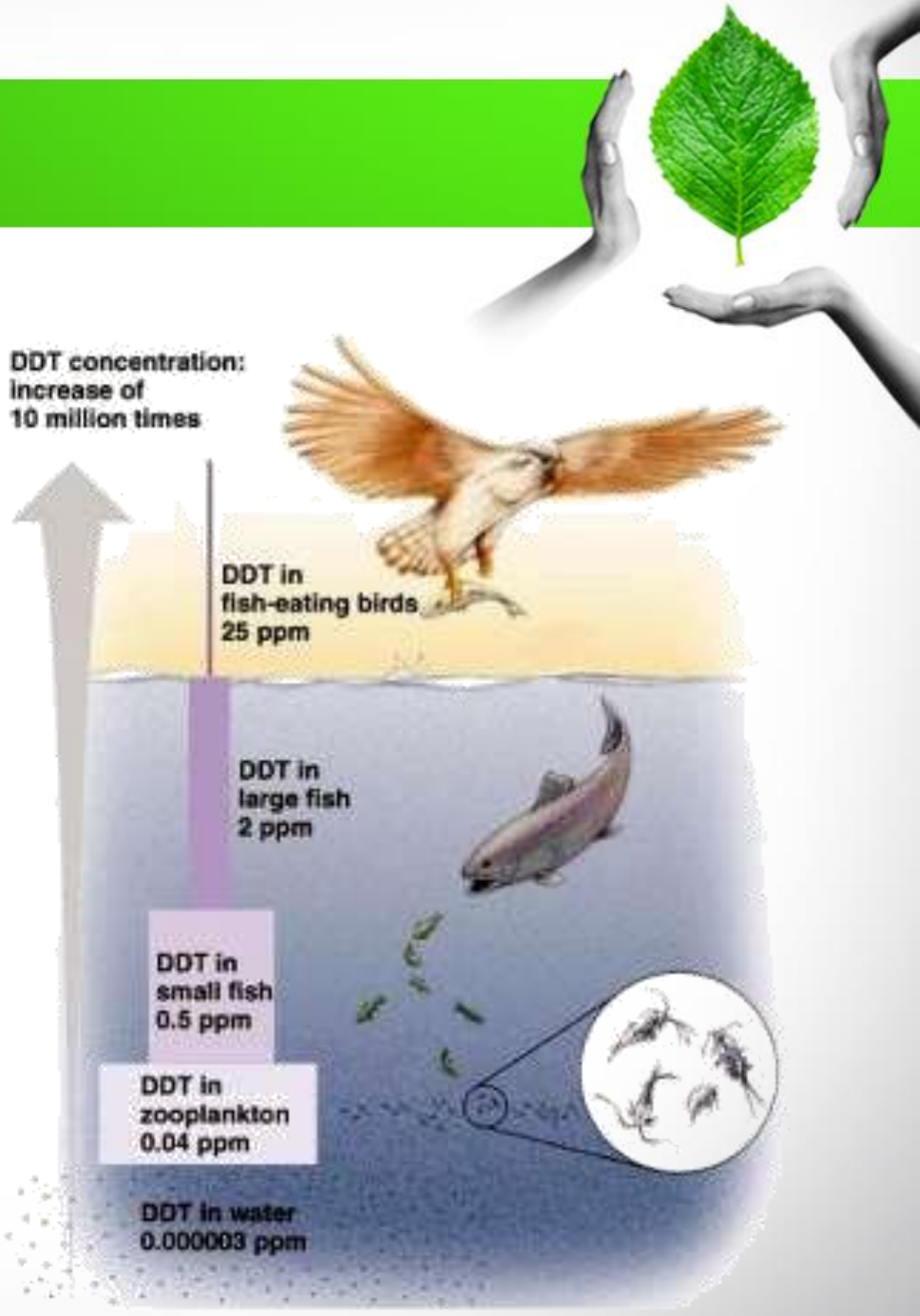
Requirement 3c3

- Describe the impact of a waterborne pollutant on an aquatic community. Write a 100-word report on how that pollutant affected aquatic life, what the effect was, and whether the effect is linked to **biomagnification**.
- Examples to use:
  - DDT
  - Mercury
  - PCB's

Requirement 3c3

What is Biomagnification?

- Refers to the process whereby certain substances such as pesticides or heavy metals work their way into lakes, rivers and the ocean, and then move up the food chain in progressively greater concentrations as they are incorporated into the diet of aquatic organisms such as zooplankton, which in turn are eaten perhaps by fish, which then may be eaten by bigger fish, large birds, animals, or humans.



Requirement 3d

3. Do ONE activity from seven of the following categories (using the activities in the merit badge pamphlet as the basis for planning and carrying out your projects):
   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.
      3. Photograph an area affected by erosion. Share your photographs with your counselor and discuss why the area has eroded and what might be done to help alleviate the erosion.

Requirement 3d1

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.

Soil Erosion

In this experiment you can find out how soil erosion happens and learn about one way to prevent soil erosion.

Procedure

Step 1 – Get permission before you dig up any soil for this experiment.

Step 2 – Place cut-up strips of newspaper into a bucket and fill the bucket with water. Stir occasionally. Leave the newspaper in the water until it falls apart and becomes a mushy mix of paper and water. This may take a few days.

Step 3 – Build three long, narrow boxes out of wood, shoe boxes, or plastic or metal pipe. If you use cardboard, line the boxes with plastic bags or foil and cover any seams with adhesive or duct tape to prevent leaking.

Requirement 3d1

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.

Soil Erosion (continued)

Procedure

Step 4 – 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.”

Step 5 – Fill boxes 1 and 2 with garden soil so that the surface is about half an inch below the top edges of the boxes.

Step 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.

Step 7 – Drain off the water from the newspaper mix. Take a handful of the mush, 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 the newspaper mixture. Let it sit over night.

Requirement 3d1

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.

Soil Erosion (continued)

Procedure

Step 8 – The following day, line up the three boxes in a row. Place a brick, large rock, or book under the uncut end of each box. Place a collecting pan, jar, or cap under the lower end of each box below the cutout V. Photograph or make a drawing of each box.

Step 9 – Fill the watering can with a measured amount of tap water. Standing at the higher end of box 3, 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, and 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.

Step 10 – Repeat step 9 for boxes 2 and 3, using the same amount of water each time. Photgraph or make a drawing of each box to show the changes.

.

Requirement 3d2

Perform an experiment to determine the effect of an oil spill on land. Discuss your conclusions with your counselor.

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. Do this experiment to find out how oil pollution on land affects plants.

Procedure

Step 1 – Set out a pitcher of tap water for 24 hours. Obtain four small potted plants, such as pansies or another fast-growing annual flower. Label the pots “A,” “B,” “C,” and “D.”

Step 2 – On day 1, place the four plants in a sunny window. Water each plant with the same amount of tap water from your pitcher.

Requirement 3d2

Perform an experiment to determine the effect of an oil spill on land. Discuss your conclusions with your counselor.

Oil Pollution on Land (continued)

Procedure

Step 3 – Use a ruler to measure each plant. In your notebook, record their heights, number of leaves, and any other important characteristics you observe.

Step 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 oil on the soil of plant C. Pour 3 teaspoons of oil on the soil of plant D. Do not put any oil on the soil of plant A.

Step 5 – On day 2, water each plant with half a cup of water from the pitcher. Do not overwater the plants.

Step 6 – Examine each plant daily for the next three days. Write your observations in your notebook. On day 3, again measure the height of each plant and record the number of leaves. Also record in your notebook any color changes.

Step 7 – At the end of your experiment, dispose of the soil contaminated with oil. Contact your local EPA offices or hazardous waste agency to find out where to take the soil for proper disposal.

Requirement 3d2

Perform an experiment to determine the effect of an oil spill on land. Discuss your conclusions with your counselor.

Oil Pollution on Land (continued)

Observations

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

Conclusions

Oil is one of many toxic substances that can be absorbed by soil. Explain why it is important to keep cars maintained so they do not leak oil, and to collect used oil from gas stations and garages for recycling.

Requirement 3d3

- Photograph an area affected by erosion. Share your photographs with your counselor and discuss why the area has eroded and what might be done to help alleviate the erosion.

Example Photograph

Requirement 3d3

Pollution from Soil Erosion

- Sediment is tiny particles of soil and undissolved solid material carried by water
  - Sediment clouds water, making it difficult for light to reach organisms and plants that require photosynthesis for energy production.
  - Sediment may also carry pesticides and toxic chemicals.

Requirement 3e

3. Do ONE activity from seven of the following categories (using the activities in the merit badge pamphlet as the basis for planning and carrying out your projects):
   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 on the species and discuss it with your counselor.
      3. With your parent's and counselor's approval, work with a natural resource professional to identify two projects that have been approved to improve the habitat for a threatened or endangered species in your area. Visit the site of one of these projects and report on what you saw.

Requirement 3e1

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.

Ohio's Endangered Species
Click for listing

- **Endangered:** A native species or subspecies threatened with extirpation from the state. The danger may result from one or more causes, such as habitat loss, pollution, predation, interspecific competition, or disease.

Requirement 3e2

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.

How Does an Endangered Species Recover?

Sometimes a commitment of time, money, and other resources can bring a species back from the edge of extinction. In this activity, you will research one such species and learn its recovery story.

Procedure

Step1 – Using resources you have found at the library, at home, or on the internet (with your parent's permission), make a list of endangered species that have recovered. You could write to the World Wildlife Fund and other organizations that focus on plant or wildlife conservation.

Step 2 – Choose one species that has recovered from near-extinction and research how it recovered. Find out what is the status of the species today.

Step 3 – Write a 100 word report on the species.

Step 4 – Discuss your report with your counselor.

Requirement 3e3

With your parent's and counselor's approval, work with a natural resource professional to identify two projects that have been approved to improve the habitat for a threatened or endangered species in your area. Visit the site of one of these projects and report on what you saw.

Lake Erie Water Snake

Indiana Bat

Kirtland’s Warbler

Requirement 3f

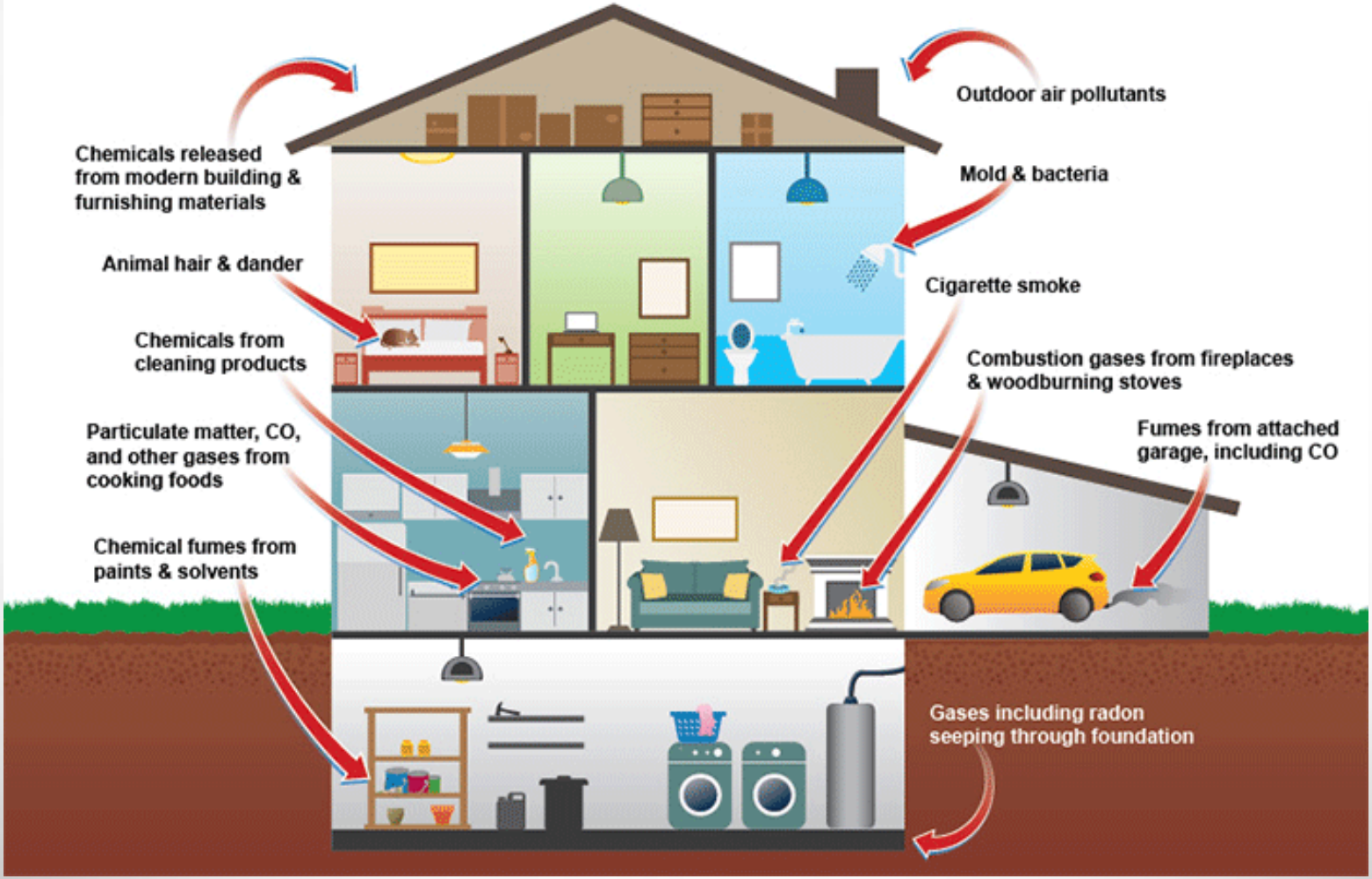
3. Do ONE activity from seven of the following categories (using the activities in the merit badge pamphlet as the basis for planning and carrying out your projects):
   f. Pollution Prevention, Resource Recovery, and Conservation
      1. Look around your home and determine 10 ways your family can help reduce pollution. Practice at least two of these methods for seven days and discuss with your counselor what you have learned.
      2. Determine 10 ways to conserve resources or use resources more efficiently in your home, at school, or at camp. Practice at least two of these methods for seven days and discuss with your counselor what you have learned.
      3. Perform an experiment on packaging materials to find out which ones are biodegradable. Discuss your conclusions with your counselor.

Requirement 3f1

- What happens to the chemicals and solvents you use to clean your house?
  - When you clean the toilet or bathtub, what happens to the chemicals that go down the drain?
  - If you live in a city, it goes to a water treatment plant where it is filtered and treated so it can be reused.
  - If you live in a rural area, it goes to your septic tank, then filters down into the soil
  - When this waste water contains toxic chemicals, the chemicals also enter the groundwater.

Requirement 3f1

Sources of Household Pollution



Requirement 3f1

Toxic Chemicals

Requirement 3f1

Ideas for Ways You Can Reduce Pollution

- Take the bus
- Use an electric lawnmower
- Turn of f the garden hose when not in use
- Keep car tires properly inflated
- Wear a sweater in the winter
- Walk or ride a bike to school
- Pay bills online
- Use cloth napkins
- Use cloth kitchen towels
- Use bath towels more than once
- Wear clothes twice before laundering
- Insulate your house
- Turn up the Air Conditioner
- Turn down the furnace
- Use fluorescent light bulbs
- Replace shower heads with water conservation versions
- Don’t use chemical fertilizers on your lawn
- Don’t idle the car
- Drive the speed limit
- Use recycled paper
- Don’t burn wood in the fireplace
- Don’t burn leaves
- Keep furnace filters clean
- Carpool
- Use fabric/reusable shopping bags
- Recycle everything
- Give old stuff to charity rather than throwing it out
- Filter water; don’t buy water in plastic bottles
- Turn off computers; don’t leave them on standby
- Don’t use aerosol sprays
- Take short showers, not baths
- Mulch lawnmower clippings

Requirement 3f1

Practice two ways your family can reduce pollution for seven days.

Pollution Prevention Project								
	Method	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1								
2								

Requirement 3f2

20 Easy Ways to Conserve Resources

1. Make sure to use your clothes washer and dryer only when you have a full load. You could save 1,000 gallons of water/month!
2. Pick up some reusable cloth bags to use at your local grocery store. Say no to both, "paper" and "plastic!" It can take up to a thousand years for plastic bags to degrade. Paper bags (although recyclable), aren't much better. In the US alone, approximately 14,000,000 trees are cut down each year to be made into paper bags.
3. Replace your old light bulbs with energy-saving LED bulbs. Sure, they may cost more money, but you will save on your energy bill in the future and they last longer. An LED light can be seventy-five percent more energy efficient than your old incandescent light bulbs and can last up to twenty-five times longer.
4. Try shortening your shower by just a minute. You could save 150 gallons of water per month! And it's not just water your shower uses. Running your shower for just 5 minutes is the energy equivalent of leaving a light on for 14 straight hours.
5. Skip the dishwasher built-in dry option and simply air dry your dishes. Doing this conserves energy.
6. Turn off lights, fans, radios, and televisions when leaving a room, even if you are going to bone only a few minutes.
7. Shut off the faucet when you are brushing your teeth or washing your face.
8. Reduce, reuse, and recycle paper products, glass, aluminum, steel, and plastic items.
9. Lower the thermostat. If each American household were to lower its average heating temperature by 6 degrees over a 24 hour period, the equivalent of 500,000 barrels of oil would be saved.

Requirement 3f2

20 Easy Ways to Conserve Resources

10. Set your fridge between 36-38 F degrees and freezer to be between 0-5 F degrees.
11. Eat no meat and animal products for one day a week. One study estimated that a quarter pound of beef is equal to approximately 460 gallons of water. Factor in the methane, as well as other greenhouse gas emissions of cattle, and the fossil fuels it took to get the beef to you. Even one day of being a vegetarian is good for your health and the Earth.
12. UNPLUG unused appliances. Even when powered off, plugged-in appliances use electricity.
13. Plant trees to shade your home. You can save money on air conditioning.
14. Buy used furniture and re-purpose it. You save money and trees (plus, create original furniture!)
15. Close vents and doors in unused rooms to conserve heat.
16. Buy a stylish ceramic mug for your daily cup of coffee instead of using a disposable cup. If you're someone who buys a cup of coffee or tea in a disposable cup every day, your cups alone are an estimated 23 pounds of waste per year.
17. Wrap your water heater in an insulated blanket.
18. Turn your computer off when you go to sleep. You'll conserve energy.
19. Water your lawn in the early morning when it is cooler and drier. Watering in mid-day, especially when it is hot and dry, leads to water evaporation. Watering in the evening can also work, but some lawn care experts say that can put your lawn at much higher risk for fungus and other grass ailments.
20. Make sure to inflate your tires properly. This preserves the life of the tires, creates a safer ride, and saves gas.

Requirement 3f2

Practice at least two ways to conserve resources or use resources more efficiently for seven days in your home, at school, or at camp and discuss with your counselor what you have learned.

Resource Conservation Project								
	Method	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1								
2								
3								

Requirement 3f3

Perform an experiment on packaging materials to find out which ones are biodegradable. Discuss your conclusions with your counselor.

Biodegradable Packing Materials

Items purchased online or from mail-order catalogs are shipped in boxes and protected with packing materials that range form plastic bubble wrap to popcorn. Packing materials sometimes end up as litter along roadsides or take up space in landfills. In this experiment, you will find out which packing materials are biodegradable.

Procedure

Step 1 – Label four resealable plastic bags “1,” “2,” “3,” and “4.”

Step 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.

Step 3 – In bag 1, place six small strips of newspaper.

Step 4 – In bag 2, place six foam packing peanuts.

Step 5 – In bag 3, place six pieces of unbuttered, unsalted popped popcorn.

Requirement 3f3

Perform an experiment on packaging materials to find out which ones are biodegradable. Discuss your conclusions with your counselor.

Biodegradable Packing Materials (continued)

Procedure

Step 6 – In bag 4, place a small piece of plastic bubble wrap.

Step 7 – Fill each bag almost to the top with garden soil. Leave enough space to allow the bag to be closed.

Step 8 – Pour half a cup of tap water into each plastic bag.

Step 9 – Close each bag. Place all four bags near a sunny window.

Step 10 – After two days, open the plastic bags, stir the soil, add half a cup of tap water, and reclose the bags.

Step 11 – Wait three more 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.

Requirement 3f3

Perform an experiment on packaging materials to find out which ones are biodegradable. Discuss your conclusions with your counselor.

Biodegradable Packing Materials (continued)

Observations

1. Which packing materials showed signs of decomposition?
2. Which do you think were biodegradable? Which were nonbiodegradable?
3. Explain the differences between the materials that are biodegradable and the ones that are nonbiodegradable.

Conclusions

Based on the results of this experiment, make a statement about which kinds of packing materials are biodegradable and would create less solid waste. What other kinds of biodegradable packing materials would protect fragile items during transport?

Requirement 3g

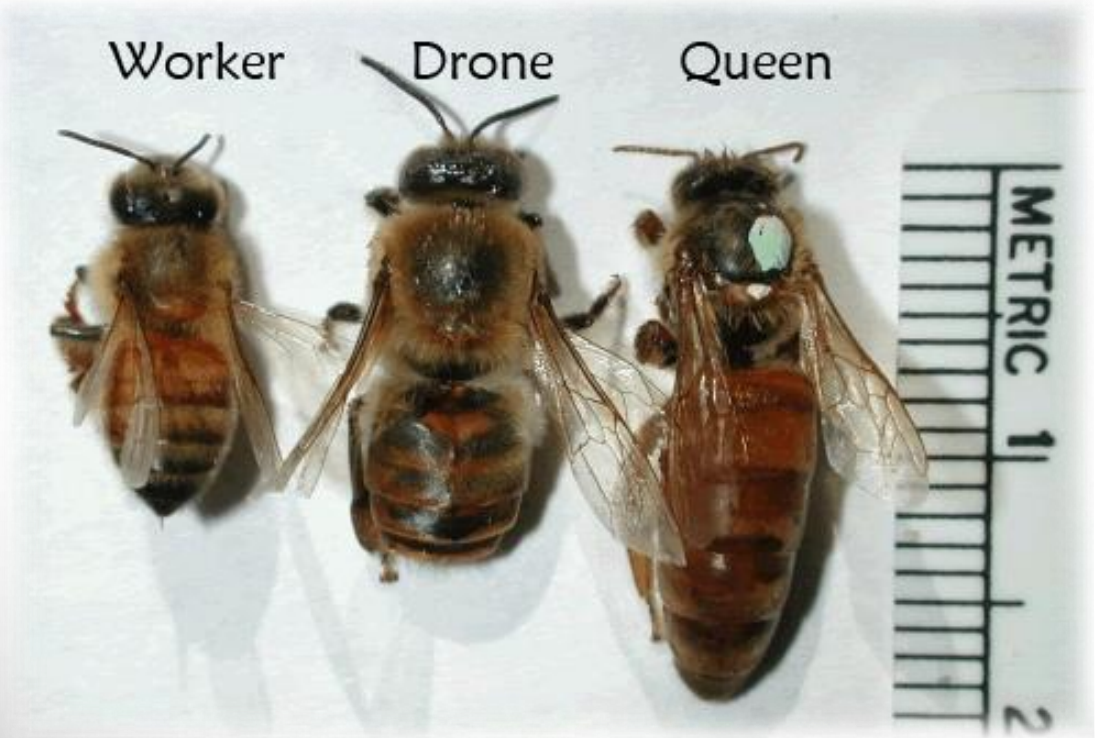
3. Do ONE activity from seven of the following categories (using the activities in the merit badge pamphlet as the basis for planning and carrying out your projects):

    g. Pollination

    1. Using photographs or illustrations, point out the differences between a drone and a worker bee. Discuss the stages of bee development (eggs, larvae, pupae). Explain the pollination process, and what propolis is and how it is used by honey bees. Tell how bees make honey and beeswax, and how both are harvested. Explain the part played in the life of the hive by the queen, the drones, and the workers.
    2. Present to your counselor a one-page report on how and why honey bees are used in pollinating food crops. In your report, discuss the problems faced by the bee population today, and the impact to humanity if there were no pollinators. Share your report with your troop or patrol, your class at school, or another group approved by your counselor.
    3. Discuss with your counselor the effectiveness of native bees as pollinators. Identify some of the native bees found in your area. Construct and install a native bee house.

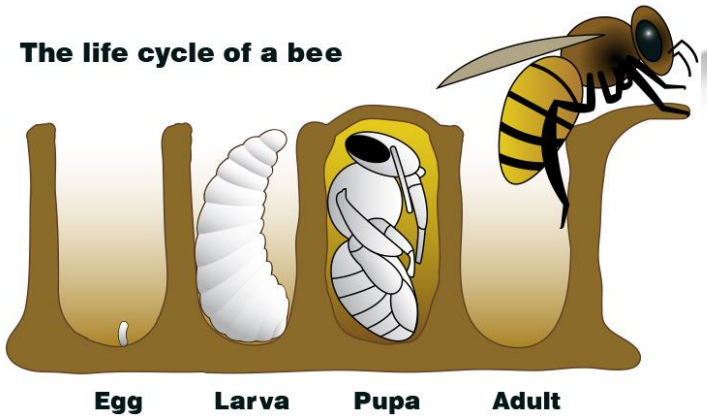
Requirement 3g1

Using photographs or illustrations, point out the differences between a drone and a worker bee.



Requirement 3g1

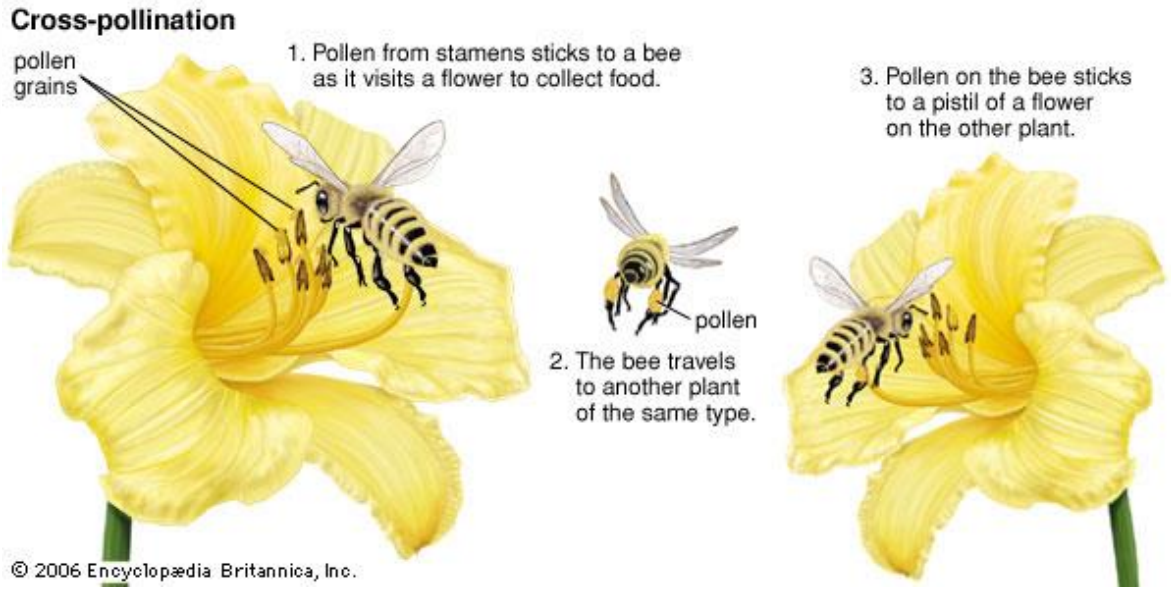
Discuss the stages of bee development (eggs, larvae, pupae). Explain the part played in the life of the hive by the queen, the drones, and the workers.



Development from egg to emerging bee varies among queens, workers, and drones. Queens emerge from their cells in 15–16 days, workers in 21 days, and drones in 24 days. Only one queen is usually present in a hive. New queens develop in enlarged cells through feeding of royal jelly by workers. When the existing queen ages or dies or the colony becomes very large, a new queen is raised by the worker bees. If the hive is too large, the old queen will take half the hive in a swarm. This occurs a few days prior to the new queen hatching. If several queens emerge they will fight. Once one has eliminated the others, she will go around stinging and killing the other queen pupae. The queen takes one or several nuptial flights to mate with drones which die after mating. After mating the queen begins laying eggs. A fertile queen is able to lay fertilized or unfertilized eggs. Each unfertilized egg develops into a drone. The fertilized eggs develop into either workers or virgin queens (if fed exclusively royal jelly). The average lifespan of a queen is three to four years; drones usually die upon mating or are expelled from the hive before the winter; and workers may live for a few weeks in the summer and several months in areas with an extended winter.

Requirement 3g1

Explain the pollination process of honey bees.



- The most important thing that bees do is pollinate. Pollination is needed for plants to reproduce, and so many plants depend on bees or other insects as pollinators.
- When a bee collects nectar and pollen from the flower of a plant, some pollen from the stamens—the male reproductive organ of the flower—sticks to the hairs of her body. When she visits the next flower, some of this pollen is rubbed off onto the stigma, or tip of the pistil—the female reproductive organ of the flower. When this happens, fertilization is possible, and a fruit, carrying seeds, can develop.

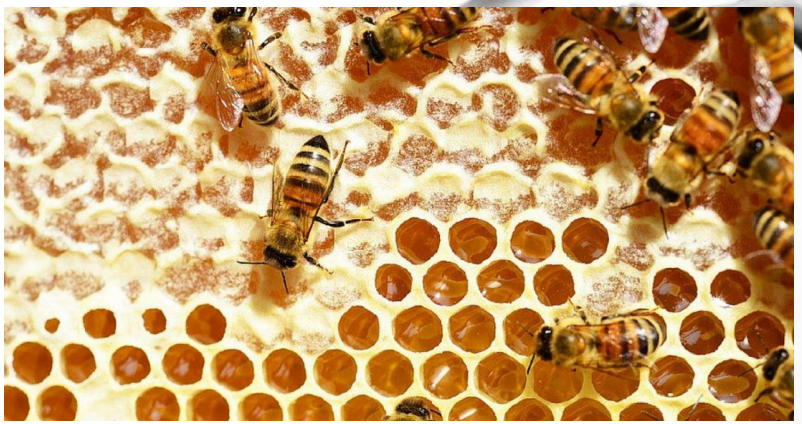
Requirement 3g1

Explain what propolis is and how it is used by honey bees.

- Along with pollen, nectar, and water, honey bees collect resins from plants and trees.
- The bees load these sticky resins into the pollen baskets on their hind legs and carry them back to the hive.
- These resins, or propolis, can be used to smooth rough surfaces and seal crevices, which allows the colony to control airflow and maintain homeostasis inside the hive.
- Propolis has also been found to have antimicrobial properties.
- When a colony is sick, bees collect extra propolis to fight off infection.

Requirement 3g1

Tell how bees make honey and beeswax, and how both are harvested.



- Bees collect a sugary juice called nectar from a blossom by sucking it out with their proboscis.
- They store it in their honey stomach, which is different from their food stomach.
- When they have a full load, they fly back to the hive.
- There, they pass it on through their mouths to other worker bees. As the nectar is chewed and passed from bee to bee, enzymes change its pH and other chemical properties until it gradually turns into honey.
- The bees then store it in honeycomb cells, which are like tiny jars made of wax.
- The honey is still a bit wet, so they fan it with their wings to make it dry out and become more sticky.
- When it's ready, they seal the cell with a wax lid to keep it clean.

Requirement 3g1

Tell how bees make honey and beeswax, and how both are harvested.

- The glands of worker bees convert the sugar contents of honey into wax, which oozes through the bee's small pores to produce tiny flakes of wax on their abdomens.
- Workers chew these pieces of wax until they become soft and moldable, and then add the chewed wax to the honeycomb construction.

Requirement 3g2

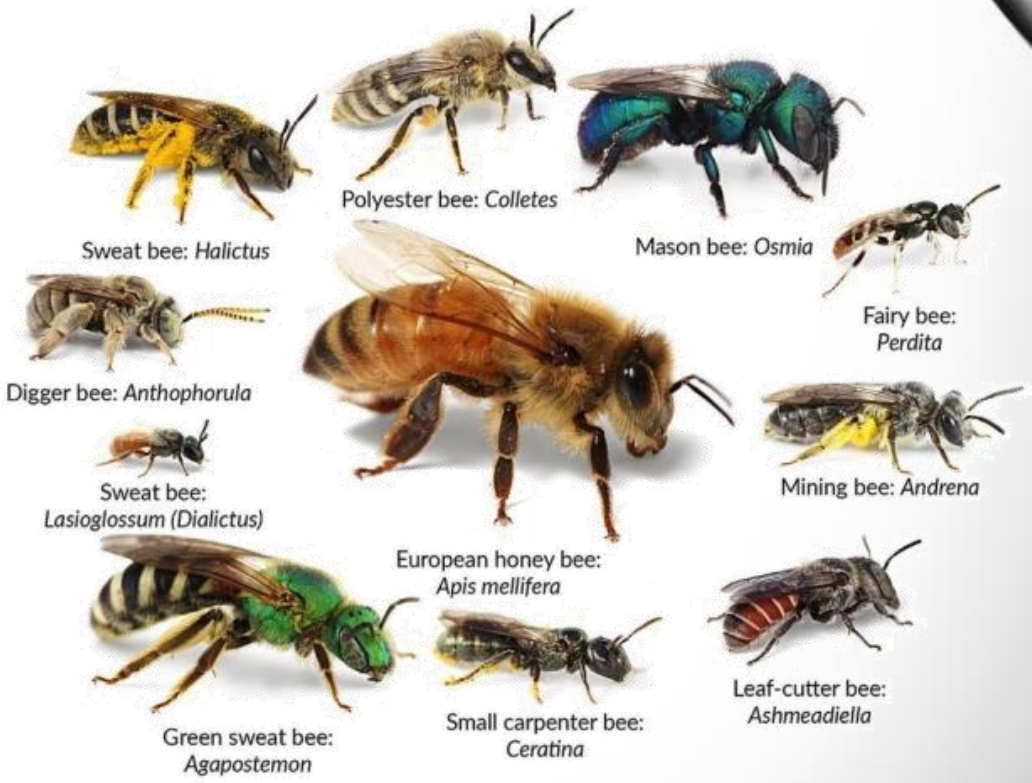
Present to your counselor a one-page report on how and why honey bees are used in pollinating food crops. In your report, discuss the problems faced by the bee population today, and the impact to humanity if there were no pollinators. Share your report with your troop or patrol, your class at school, or another group approved by your counselor.

Hives infested with a parasitic mite named *Varroa destructor*, has become a major contributor to the demise of bee colonies worldwide.

Requirement 3g3

Native Bees

- Ohio is home to approximately 500 native bee species. These diverse bees play important roles as pollinators of agricultural crops and native plants.
- Mason bees, mining bees, leaf cutting bees and sweat bees are just a few of the most common types of bees seen in gardens and landscapes.
- Native bees are facing many threats, such as lack of forage (flowers for food), pests, pathogens, pesticides, invasive plants, climate change and lack of suitable nesting sites.



Requirement 3g3

Native Bee Biology

- Native bees have evolved with the existing flora and some have established intricate relationships with particular flowers.
- Conserving populations of native bees is important because they are valuable pollinators of many plant species, often performing pollination more effectively than honey bees.
- Understanding some of the characteristics of native bees will help foster a positive environment for all bees.
- Native bees can be divided into three groups: social bees (bumble bees), solitary ground-nesting bees (such as mining bees) and solitary cavity-nesting bees (including mason bees and leaf cutting bees).
- Honey bees are social bees, but they are native to Europe and Asia, not North America.

Requirement 3g3

Native Bees

Social Bumble Bee

Ground Nesting Bee

Leaf Cutting Bee

Mason Bee

Requirement 3g3

Discuss with your counselor the effectiveness of native bees as pollinators. Identify some of the native bees found in your area. Construct and install a native bee house.

- **Bee houses** (or **bee hotels**) are similar to bird houses, but instead of attracting birds, they attract native solitary bee species. Unlike honey bees, these solitary bees are extremely docile and *up to three times more effective as pollinators*. You won't get any honey, but you will enjoy better flowers, thriving plants, and healthier vegetables in your garden!
- Click on the following link for Building and Managing Bee Hotels for Wild Bees

Requirement 3h

3. Do ONE activity from seven of the following categories (using the activities in the merit badge pamphlet as the basis for planning and carrying out your projects):

    h. Invasive Species

    1. Learn to identify the major invasive plant species in your community or camp and explain to your counselor what can be done to either eradicate or control their spread.
    2. Do research on two invasive plant or animal species in your community or camp. Find out where the species originated, how they were transported to the United States, their life history, how they are spread, and the recommended means to eradicate or control their spread. Report your research orally or in writing to your counselor.
    3. Take part in a project of at least one hour to eradicate or control the spread of an invasive plant species in your community or camp.

Requirement 3h1

Learn to identify the major invasive plant species in your community or camp and explain to your counselor what can be done to either eradicate or control their spread.

Ohio Invasive PlantSpecies

Click for listing

Phragmites

Garlic Mustard

Purple Loosestrife

Muliflora Rose

Japanese Honeysuckle

Requirement 3h2

Do research on two invasive plant or animal species in your community or camp. Find out where the species originated, how they were transported to the United States, their life history, how they are spread, and the recommended means to eradicate or control their spread. Report your research orally or in writing to your counselor.

Ohio Invasive Species

Click for listing

Emerald Ash Borer

Asian Carp

Zebra Mussels

Requirement 3h3

Take part in a project of at least one hour to eradicate or control the spread of an invasive plant species in your community or camp.

Requirement 4

4. Choose two outdoor study areas that are very different from one another (e.g., hilltop vs. bottom of a hill; field vs. forest; swamp vs. dry land). For BOTH study areas, do ONE of the following:
   a. Mark off a plot of four square yards in each study area, and count the number of species found there. Estimate how much space is occupied by each plant species and the type and number of non-plant species you find. Report to your counselor orally or in writing the biodiversity and population density of these study areas. Discuss your report with your counselor.
   b. Make at least three visits to each of the two study areas (for a total of six visits), staying for at least 20 minutes each time, to observe the living and nonliving parts of the ecosystem. Space each visit far enough apart that there are readily apparent differences in the observations. Keep a journal that includes the differences you observe. Discuss your observations with your counselor.

Requirement 4a

Study Plots Activity

Procedure

Step 1 – In your chosen study areas, identify the ecosystem types.

Step 2 – Begin at one of the two ecosystems you have selected. Using pipes, staves, or string, mark out a 6 foot by 6 foot square. This is study plot 1.

Step 3 – 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 note of the change. Note also whether the plot is flat or on a slope.

Step 4 – Next, look at the living things in the plot. If you see any nonplant species (fungi, insects, birds, etc.), note their common names or draw pictures in your notebook for later identification. Using a field guide, identify all the different plants and nonplants you see, or make a drawing of each in your notebook. Use a magnifying glass If needed, to see the features of each plant and nonplant species.

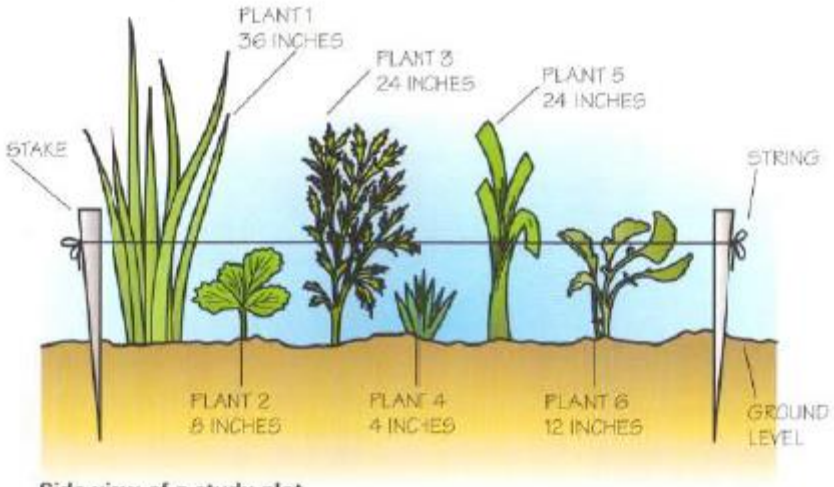
Requirement 4a

Study Plots Activity (continued)

Procedure

Step 5 – Estimate how much space each plant species occupies in the plot. For example, in a grassy meadow, one species of grass might occupy about 90 percent of the space in the plot. Record this estimate next to the name of each species in your notebook.

Step 6 – Using a yardstick, measure the height range of identified plant species and add the data to your notes. Use these measurements to draw a side view of your study plot. Try to draw the plants to scale (see illustration below.)



Side view of a study plot

Requirement 4a

Study Plots Activity (continued)

Step 7 – Go to the second ecosystem. Repeat steps 1 through 6 for plot 2.

Observations

1. How many nonplant species did you identify in each study plot? How many plant species?
2. What was the difference between the number of nonplant and plant species for the study plots?
3. Which plot was more biodiverse?
4. What, if any, species did you find in both plots?

Requirement 4b

Nature Study Activity

In this activity, you will make three visits to each of the two study area, staying for at least 20 minutes each time to observe the living and nonliving parts of the entire ecosystem, not just your study plot. Your results will vary depending upon when you choose to observe the area. Your visits must be spread out enough that your observations show differences between your visits.

Procedure

Step 1 – Decide on your schedule for visiting each of the study areas. Make sure your parent or counselor agrees with your plan.

Step 2 – On your first visit, arrive quietly, making as little noise as possible. Find a good place to observe wildlife. 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, or dry. Note whether your study area is flat or on a slope. Dray a small map of the area in your notebook, showing how it looks from where you are sitting.

Step 3 – Once you are settled and have noted the environmental conditions, begin your observation period. Identify any plants you see (by using field guides or by drawing them in your notebook for later identification). Note the stage of life cycle for each plant species – that is, look for buds, leaves, flowers, seeds, and so on. Record these data in your notebook.

Requirement 4b

Nature Study Activity (continued)

Procedure

Step 4 – Each time you see another species, write down its common name and describe its appearance or behavior. If you do not know its 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, you may take photographs.

Step 5 – Note and describe any sounds you hear. If you have a battery-operated recorder, turn it on and let it run for the 20 minute observation period. When an animal makes a sound, note the time in your notebook so that you can identify the taped sound later.

Step 6 – If you have binoculars, try to identify nonplant species that are far away. For tiny organisms such as insects and worms, use a magnifying glass. Do not pick up or disturb any organisms. Your role is to observe, not to interact with living things.

Requirement 4b

Nature Study Activity (continued)

Step 7 – After your observation period of at least 20 minutes is over, 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 other observations that you were not able to make during the study period.

Step 8 – Visit the area and repeat your observations two more times, according the schedule you set up in step 1. Be sure to observe from exactly the same spot each time.

Observations

1. During your study periods, which changes did you observe in the plant species that you identified?
2. At which times did you see more nonplant species (e.g., birds, insects, fungi) during your observation period?
3. How did the time of day or season affect your observations?
4. How did environmental conditions affect your observations?

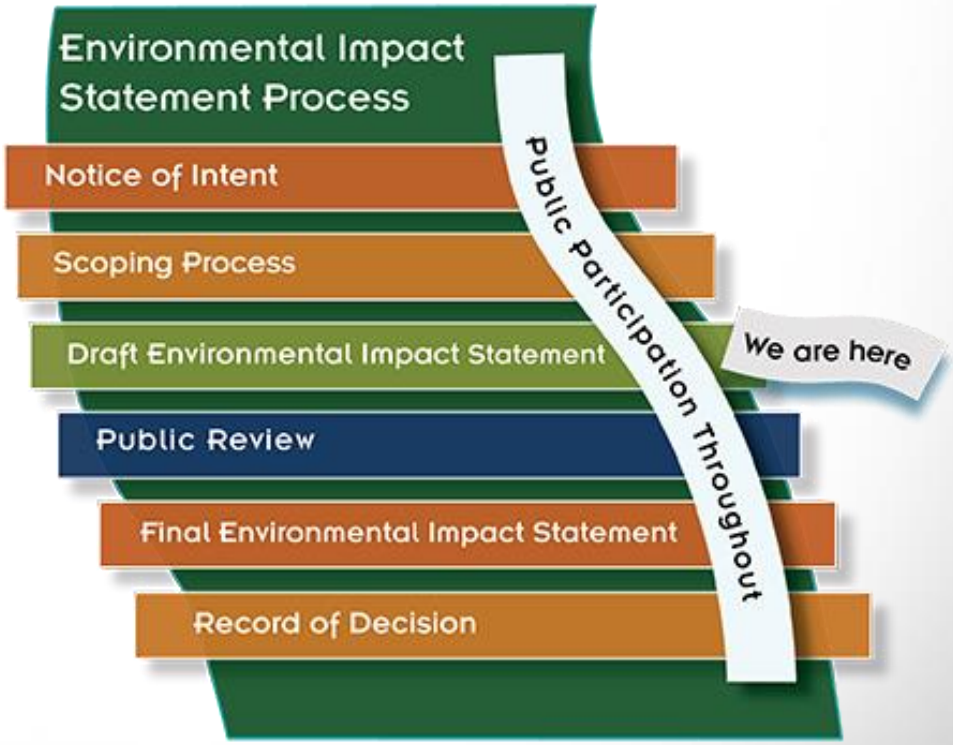
Conclusions

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

Requirement 5

Describe a construction project that might be proposed for your community by your local or state government.

Using the suggested construction projects provided or a plan you create on your own, identify the items that would need to be included in an environmental impact statement for the project planned.



Requirement 5

Suggested Construction Projects

- Building a new highway or bridge in a rural area.
- Building a new school or library on farmland.
- Building a bicycle path or nature trail in a wooded area.
- Paving over a vacant lot for parking cars.
- Create your own construction project.

Include a description of the size and nature of the project and how the community will benefit from it.

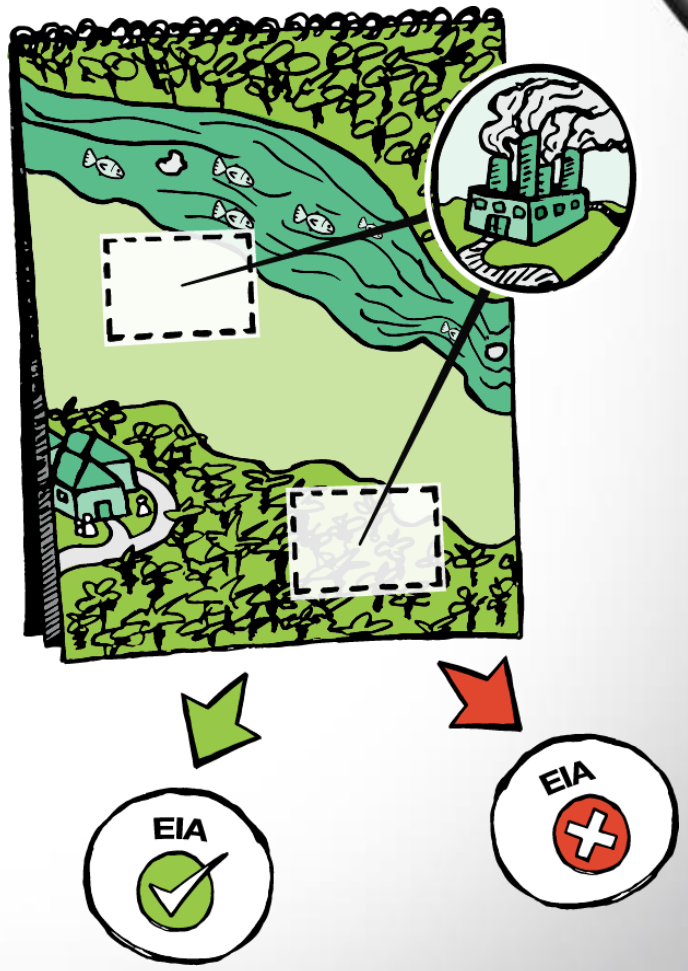
Requirement 5

Environmental Impact Statement Procedure

In this activity, you will identify the items that would need to be included in an environmental impact statement for a hypothetical (imaginary) construction project.

Procedure

Step 1 – In your notebook, describe a construction project that might be proposed for your community by your local or state government. Suggested projects include building a hew highway or bridge in a rural area; building a new school or library on farmland; building a bicycle path or nature trail in a wooded area; or paving over a vacant lot for parking cars. With the approval of your counselor, you may create your own construction project. Include a description of the size and nature of the project and how the community will benefit from it.



Requirement 5

Environmental Impact Statement Procedure (continued)

In this activity, you will identify the items that would need to be included in an environmental impact statement for a hypothetical (imaginary) construction project.

Procedure

Step 2 – Choose a suitable site for your project and visit it. (The project is imaginary, but the site must be a real place.) Record the following data for the project site:

a. What types of plant and animal life are at the site?
b. What type of ecosystem (forest, grassland, desert, etc.) is it?
c. Has it been disturbed before?
d. Is it a habitat for an endangered or threatened species?
e. Does it slope? Would the soil be in danger of erosion during construction?
f. Are there streams or wetlands such as marshes at the site?
g. Is there reason to believe important fossils or artifacts are at the site?
h. Are there activities on lands next to the site?

Requirement 5

Environmental Impact Statement Procedure (continued)

In this activity, you will identify the items that would need to be included in an environmental impact statement for a hypothetical (imaginary) construction project.

Procedure

Step 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? If you are planning a highway, would it cut through a state or local park? Will a bike path allow area residents to bicycle to school or work rather than drive cars?

Step 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 disturb forests, grasslands, deserts, or other ecosystems?
c. Will it disturb any habitats of endangered or threatened species?

Step 5 – Identify any effects on the project that probably will be harmful but cannot be avoided. A bridge over a river to connect two existing roads, for example, probably cannot be built elsewhere, so the project's negative effects may have to be accepted.

Requirement 5

Environmental Impact Statement Procedure (continued)

In this activity, you will identify the items that would need to be included in an environmental impact statement for a hypothetical (imaginary) construction project.

Procedure

Step 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.

Step 7 – Discuss the trade-offs between the short and long term environmental losses and the short and long term benefits of the proposed project.

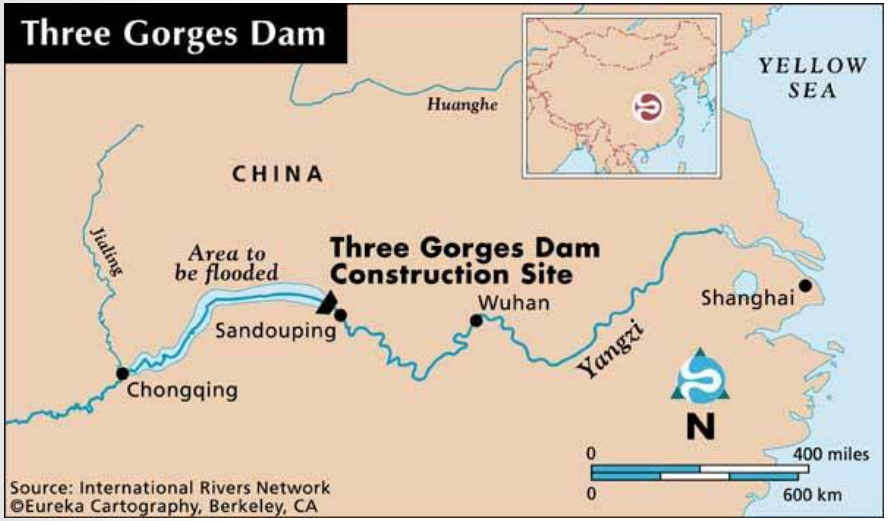
Step 8 – Determine how the proposed project would permanently prevent other users of the site. If a vacant lot is paved, for example, then that land could not be used for a community garden.

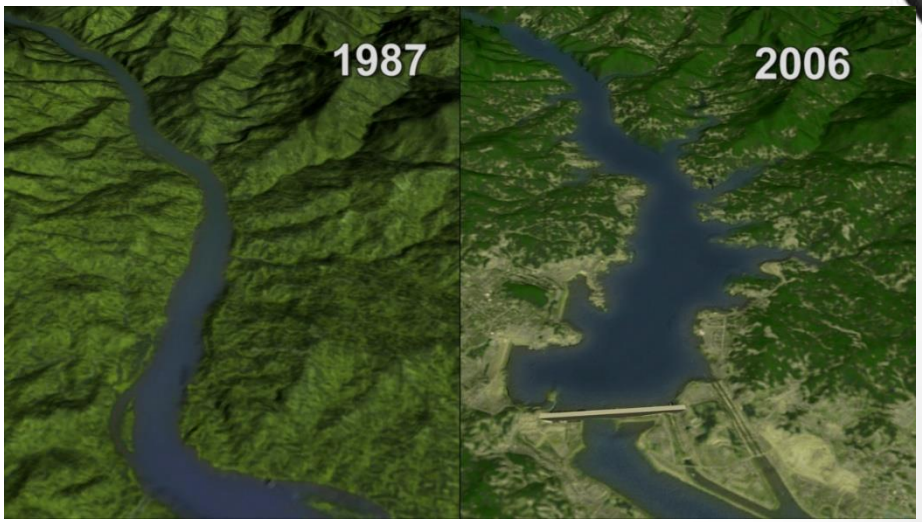
Conclusions

Based on your review of the proposed project, tell your counselor what information would need to be included in an environmental impact statement and 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.

Requirement 5

Three Gorges Dam on the Yangzi River in China



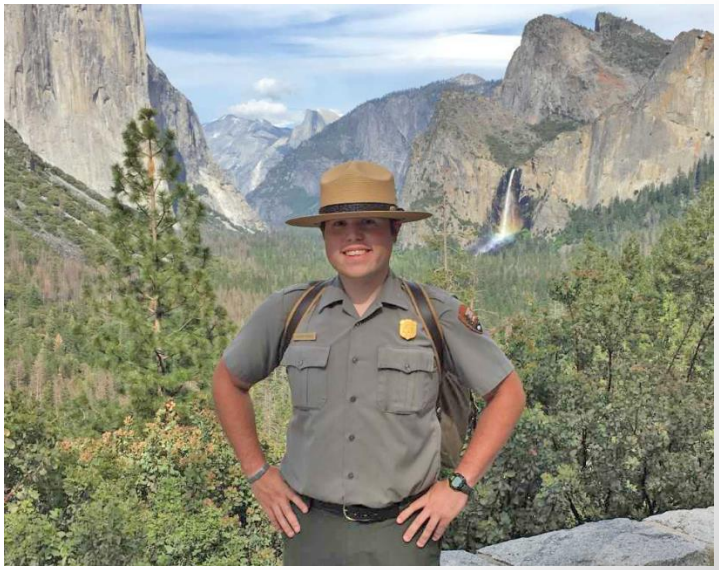


What are the pros and cons of building this dam?

Requirement 6

Requirement 6

6. Find out about three career opportunities in environmental science. Pick one and find out the education, training, and experience required for this profession. Discuss this with your counselor, and explain why this profession might interest you.



Requirement 6

Career Opportunities in Environmental Science

Air Quality Specialist
Agribusiness Manager
Agriculture Engineer
Animal Caretaker
Animal Nutritionist
Animal Physiologist
Animal/Plant Inspector
Aquaculturist
Aquatic Biologist
Biochemist
Bioengineer
Botanist
Business/Financial Manager
Commercial Fisherman
Communication Specialist
Computer Information/System Manager
Conservation Biologist
Consultant
Department of Vital Statistics
Ecologist
Ecotourism Specialist
Environmental Cartographer
Environmental Educator
Environmental Engineer
Environmental Law Officer/Lawyer
Environmental Quality Technician
Environmental Scientist/Technician
Environmental Toxicologist
Ethnobotanist
Field Biologist
Fish and Wildlife Agent
Fisheries Scientist
Fishing/Wildlife Guide
Florist/Green house Manager
Food Processing Engineer
Food Scientist Technologist
Forester
Geneticist
Golf Course Superintendent
Government Administrator
Hazardous Materials Technician
Horticulturalist
Hydrographic Survey Technician
Hydrologist
Human Resources Manager
Ichthyologist
International Trade Analyst
Land Use Planner
Landscape Architect/Contractor
Mariculturist
Marine Scientist
Marketing Manager
Meteorologist
Microbiologist
Molecular Biologist
Natural Resource Manager
Naturalist
Occupational Safety/Health Technician
Oceanographer
Ornithologist
Parasitologist
Parks and Recreation Specialist
Pest Control Specialist
Plant Physiologist
Plant Tissue Culture Technician
Professional Diver
Radio/Television Broadcaster
Remote Sensing Scientist
Research Director/Technician
Reproductive Physiologist
Rural Development Specialist
Science Writer
Soil Conservation Technician
Veterinarian Technician
Virologist
Wastewater Treatment Technician
Water Scientist
Wildlife Biologist
Zoo Animal Keeper
Zoologist