

Environmental Science for a Changing World

Oak Meadow Coursebook

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Contents

Introduction	xiii
Lesson 1: A Matter of Perspective	1
Activity A: Earth Timeline Analogy	
Activity B: Outdoor Observations	
Activity C: Understanding Maps	
Lesson 2: What <i>Is</i> Environmental Science?	9
Textbook reading: Chapter 1, An Introduction to Environmental Science, lesson 1	
Activity A: Invent-a-Word!	
Activity B: Choice Project (choose one)	
Option 1: Extinction Timeline	
Option 2: Extinct or Not?	
Option 3: Renewable and Non-Renewable Sources	
Lesson 3: The Tools of Environmental Science	17
Textbook reading: Chapter 1, An Introduction to Environmental Science, lessons 2 and 3	
Activity A: Can You Repeat That?	
Lesson 4: Exploring an Ecosystem Field Activity	23
Field Activity: Exploring an Ecosystem	
Lesson 5: Economics and Environmental Policy	31
Textbook reading: Chapter 2, Economics and Environmental Policy	

Activity choices:

Activity A: Ecosystem Services Value Survey

Activity B: Cost/Benefit Analysis

Activity C: U.S. Forest Service and National Park Service

Activity D: Protecting Land Assets

Lesson 6: Earth’s Systems and Water Cycle39

Textbook reading: Chapter 3, Earth’s Environmental Systems, lessons 1, 2, and 3

Activity choices:

Activity A: Tectonic Plates

Activity B: Aquifers

Activity C: Documentary Video

Lesson 7: Biochemical Cycles47

Textbook reading: Chapter 3, Earth’s Environmental Systems, lesson 4

Activity A: Journey of a Carbon Atom

Lesson 8: Population Ecology53

Textbook reading: Chapter 4, Population Ecology

Activity A: Identifying Biotic and Abiotic Factors

Activity B: Choice Project (choose one)

Option 1: Graphing Survivorship Curves

Option 2: Modeling Population Growth

Lesson 9: Evolution and Species Interactions63

Textbook reading: Chapter 5, Evolution and Community Ecology, lessons 1 and 2

Activity A: Artificial Selection

Activity B: Choice Project (choose one)

Option 1: Evolution and Community Ecology
Crossword Puzzle

Option 2: Observing Competition at the Bird Feeder

Option 3: “The Loves and Lies of Fireflies”

Lesson 10: Communities and Ecology69

Textbook reading: Chapter 5, Evolution and Community

Ecology, lessons 3 and 4

Activity A: “Tales of Ice-Bound Wonderlands”

Activity B: Choice Project (choose one)

Option 1: Food Web Poster

Option 2: Presentation on Invasive Species

Lesson 11: Exploration Labs77

Lab options:

Lab A: Dissecting Owl Pellets

Lab B: Studying Plant Succession

Lab C: Introduction to Biomimicry

Lesson 12: Biomes.....93

Textbook reading: Chapter 6, Biomes and Aquatic

Ecosystems, lessons 1 and 2

Activity choices:

Activity A: Biome Playlist

Activity B: African Elephants Research

Activity C: Create a Climatograph

Lesson 13: Aquatic Ecosystems99

Textbook reading: Chapter 6, Biomes and Aquatic

Ecosystems, lesson 3

Activity A: Vocabulary Crossword Puzzle

Activity B: Choice Project (choose two)

Option 1: Coral Reef Poster

Option 2: Mangrove Forest Presentation

Option 3: Hydrothermal Vent Project

Option 4: Plankton/Nekton/Benthos Poster

Option 5: Oxbow Lake Formation Project

Lesson 14: Biodiversity 105

Textbook reading: Chapter 7, Biodiversity and Conservation

Activity choices:

Activity A: Living Planet Index

Activity B Choice Project (choose one)

Option 1: International Biodiversity Legislation

Option 2: IUCN Red List of Threatened Species

Activity C: Biodiversity Interview

Lesson 15: Soundscape Ecology 113

Lab Activity: Soundscape Exploration

Lesson 16: Human Population 121

Textbook reading: Chapter 8, Human Population

Activity A: Data Analysis Practice

Activity B: Choice Project (choose one)

Option 1: Bubonic Plague Poster

Option 2: Age Structure Diagram

Lesson 17: The Environment and Health 127

Textbook reading: Chapter 9, Environmental Health, lessons 1, 2, and 3.

Activity A: Chemical Hazards

Option 1: Radon and Carbon Monoxide Assessment

Option 2: Sources of Potential Hazards

Activity B: Choice Project (choose one)

Option 1: Biomagnification Cartoon

Option 2: Disease Detective

Option 3: Diseases in the News

Activity C: Phenology Project

**Lesson 18: First Semester Wrap-Up:
Movie Week!** 135

Activity A: *A Fierce Green Fire: the Battle for a Living Planet*

Activity B: Documentary Choice (choose one)

Option 1: *Green Gold*

Option 2: *DamNation*

Lesson 19: Natural Disasters 141

Textbook reading: Chapter 9, Environmental Health, lesson 4

Exploration Lab: Construct an Earthquake-Proof Building

Activity choices:

Activity A: Interviews on Experiencing Natural Disasters

Activity B: Connecting Climate Change and Avalanches

Activity C: Natural Disaster Report

Activity D: Emergency Warning Systems

Activity E: Tsunami Prediction Technology

Activity F: Earthquake Mapping

Activity G: Literary Exploration of Disaster Recovery

Lesson 20: Urbanization 149

Textbook reading: Chapter 10, Urbanization

Activity A: Group Discussion on Urban Growth

Activity B: Choice Project (choose one)

Option 1: Identify Sprawl in Your Area

Option 2: Renovate an Inner City Area

Option 3: Light Pollution

Lesson 21: Exploring Our Impact 157

Project choices:

Project Choice A: Carbon Footprint Project

Project Choice B: Creating a Land-Use Model

Lesson 22: Our Precious Resources 169

Textbook reading: Chapter 11, Forestry and Resource

Management

Activity choices:

Activity A: The Effects of Logging on Salmon Habitat

Activity B: Timber Harvesting

Activity C: The Legacy of Dr. Waangari Muta Maathai

Lesson 23: Soil 175

Textbook reading: Chapter 12, Soil and Agriculture,
lessons 1 and 2

Activity A: Desertification Feedback Loops

Activity B: Soil Inspiration

Activity C: Choice Project (choose one)

Option 1: Dig a Soil Pit!

Option 2: Forensic Geology

Option 3: The Effects of Earthworms

Option 4: Preventing Soil Erosion Quick Lab

Option 5: Soil Depth and Compaction Quick Lab

Option 6: Managing Public Grazing Lands

Lesson 24: Agriculture 189

Textbook reading: Chapter 12, Soil and Agriculture,
lessons 3 and 4

Activity choices:

Activity A: Permaculture

Activity B: Cactus Moth Invasion

Activity C: Honeybees and Colony Collapse Disorder

Activity D: Monarch Butterflies

Activity E: Plant a Pollinator Garden

Lesson 25: Mining and Mineral Resources 197

Textbook reading: Chapter 13, Mineral Resources and Mining

Activity choices:

Activity A: Hardrock Mining and Reclamation Act

Activity B: Centralia Mine Fire

Activity C: Mining Methods

Activity D: Toxic Spill at Ajka Alumina Plant

Activity E: Virunga Documentary Project

Activity F: Chilean Mine Rescue

Activity G: Mineral Pigments in Art

Activity H: Mineral Sources of Products You Use

Lesson 26/27: Water.....205

Textbook reading: Chapter 14, Water Resources

Activity A: Exploring the Local Watershed

Activity B: Choice Project (choose one)

Option 1: Aquifer Research

Option 2: Water Sources

Option 3: Large Dams

Option 4: The Green Lagoons

Option 5: Wastewater Treatment

Option 6: Clean Water Legislation

Option 7: Pharmaceuticals in the Environment

Option 8: Xeriscaping

Option 9: Cultural Eutrophication Lab

Lesson 28: The Atmosphere.....221

Textbook reading: Chapter 15, The Atmosphere

Activity A: The Antarctic Ozone Hole

Activity B: Choice Project (choose one)

Option 1: Clean Air Act

Option 2: The Effects of Acid Precipitation

Option 3: Ozone Hole Real Time Data

Lesson 29/30: Climate Change.....229

Textbook reading: Chapter 16, Global Climate Change

Activity A: Observing the Greenhouse Effect

Activity B: Choice Project (choose one)

Option 1: Modeling Global Air Movement

Option 2: Modeling Ice Shelves on a Warming Earth

Activity C: Ecosystem Exploration/Phenology Follow-up

Lesson 31/32: Nonrenewable Energy257

Textbook reading: Chapter 17, Nonrenewable Energy

Activity A: Fossil Fuel Media Watch

Activity B: Nuclear Fission

Activity C: Speak Out

Activity D: Choice Project

Option 1: Mountaintop Removal Coal Mining

Option 2: Arctic Oil Exploration

Option 3: Seismic Oil Exploration

Option 4: Oil in the Gulf of Mexico

Option 5: Oil Spills

Option 6: Virunga Documentary Project

Option 7: Nuclear Energy

Option 8: The Future of Nuclear Waste

Option 9: Fossil Fuel Sources

Lesson 33: Renewable Energy267

Textbook reading: Chapter 18, Renewable Energy Alternatives

Activity choices:

Activity A: Large Dams

Activity B: Renewable Energy Crossword Puzzle

Activity C: Create a Sun Chart

Activity D: Tidal Energy

Activity E: Wind Farm Visit

Lesson 34: Your Household Energy Consumption275

Lab: Household Energy Consumption

Lesson 35: Waste Management: Full Circle or Not?285

Textbook reading: Chapter 19, Waste Management

Activity A: A Mockumentary

Activity B: Choice Project (choose one)

Option 1: Trash Assessment

Option 2: The Environmental Cost of Bottled Water

Activity C: Choice Project (choose two)

Option 1: Hazardous Waste Survey

Option 2: Hazardous Wastes in Businesses

Option 3: E-Waste and eCycling

Option 4: Field Trip

- Option 5: Municipal Composting Programs
- Option 6: Recycling Process
- Option 7: Waste Management Around the Globe

Lesson 36: Rising to the Challenge.....297

- Activity A: The Round River
- Activity B: Choice Project (choose one)
 - Option 1: Create a Children’s Book
 - Option 2: Free Choice or Original Idea

For Further Inspiration303

- Resource List
- Getting Involved: Citizen Science Opportunities

Appendix307

- Materials List
 - Materials List (sorted by lesson)
 - Alphabetical List of Materials
- Oak Meadow Academic Expectations
- Original Work Guidelines
- Plagiarism
- How to Cite Sources
 - Citing your source
 - In-text citations
 - To cite print sources
 - To cite online sources
 - To cite a film
- Special Considerations for Citing Images
- Works Cited

Lesson



Exploring an Ecosystem Field Activity

ecology. Together, they mean “the study of our house or home.” More specifically, ecology is the study of how organisms interact with each other and their environment. So what is this word *ecosystem* that is in the title of this lesson? Can you guess? An ecosystem is all of the living things and their physical environment in an area. Ecologists study ecosystems!

In this lesson, you are an ecologist. You are not just walking through the area where you may have passed by for years, noting that the grass is growing, there are bees in the clover, or the prickly pear cactus is blooming. This time you will be making more detailed observations, closely observing parts of your environment, with the goal of learning more about what is actually going on there.

It doesn't matter what season it is right now. If it is winter and the ground is covered with snow or everything appears “dead,” you can still do this activity. You will be revisiting this site two more times during the course of the year, and repeating the activity during different seasons. This will introduce you to the science of *phenology* (see the definition in sidebar), which is a topic of growing interest with climate change occurring throughout the world.

In this activity, you will notice that measurements are in meters. Science uses the metric system, so you will be using it throughout this course. The metric system is used throughout the world, and it provides a universally understood language. If you live in the U.S. or a country where the metric system is not commonly used, it is time to start practicing with it! It will be an advantage to you in the future to understand this common language of measurement.

ASSIGNMENT SUMMARY

- Conduct the field activity: Exploring an Ecosystem.
- Answer analysis and extension questions.

MATERIALS

- notebook for field notes
- felt pens or colored pencils of several colors
- pen or pencil
- 4–8 stakes
- string, about 50 meters
- tape measure or meter stick
- field guides to local insects and plants
- camera

Lesson 4

(continued)

Ecosystem: a community of organisms and their physical environment.

Phenology: from the root word *pheno* (appearance) and the suffix *logy* (the study of); the study of seasonal changes in nature, such as plant flowering, bird migration, and insect emergence, especially in relation to climatic conditions.

Learning Objectives

- Survey an area of land, documenting the physical features and organisms living there.
- Create a detailed site map.
- Identify possible relationships between the organisms in your environment.

Field Activity: Exploring an Ecosystem

Read through the following procedure and assemble your materials before you begin.

MATERIALS

- notebook for field notes
- felt pens or colored pencils of several colors
- pen or pencil
- 4–8 stakes
- string, about 50 meters
- tape measure or meter stick
- field guides to local insects and plants
- camera
- hand lens

Procedure

1. Find an area where you can mark off a 10 meter x 10 meter site to study. Try to choose a place where you are likely to encounter a diversity of life. Place one stake at each corner of the site. Use the string, looping it around each stake, to connect the stakes, marking off the boundaries of your site.
2. In your field notebook, record the date and the weather when you conduct your observations.
3. Examine your site. In your notebook, prepare a site map of the physical features of your site. Show the location of streams,

puddles, large rocks, sidewalks, trails, etc. Also, indicate the direction of any noticeable slope. Be sure to note the dimensions of your site on your map.

4. Now create a set of symbols to represent the organisms at your site. For example, you may want to use brown circles to represent trees, red dots to represent insects, blue triangles to represent flowers, green splotches to represent bushes, etc. Include any animal burrows, nests, animal droppings, or tracks that you see. You can also use shading to represent consistent physical features or plant life (such as a sidewalk or grass).
5. Draw your symbols on your site map, showing the relative location and abundance of each type of organism. To the side or at the bottom of your site map, include a key for your symbols.
6. If you need to make additional notes about the organisms present, record them in your notebook. For example, you may want to add additional information about the specific kinds of organisms (e.g. there are three types of moss, or there are several types of tall weeds).
7. In your field notes, also record observations about what organisms are doing. For example, an insect may be eating on a plant leaf, or a lizard could be hiding under a rock. Take additional notes about the physical characteristics of your study area, including but not limited to the following:
 - a. **Sunlight exposure:** How much of the area is exposed to sunlight?
 - b. **Rain/precipitation:** When was the last recorded rain or snow in this area? How much rain was received?
 - c. **Water drainage:** Is the area well drained? Does the soil absorb any rainfall or irrigation, does it flow down the slope, or is there any standing water?
 - d. **Vegetative cover:** How much of the area is covered by vegetation, and how much of the soil is exposed?

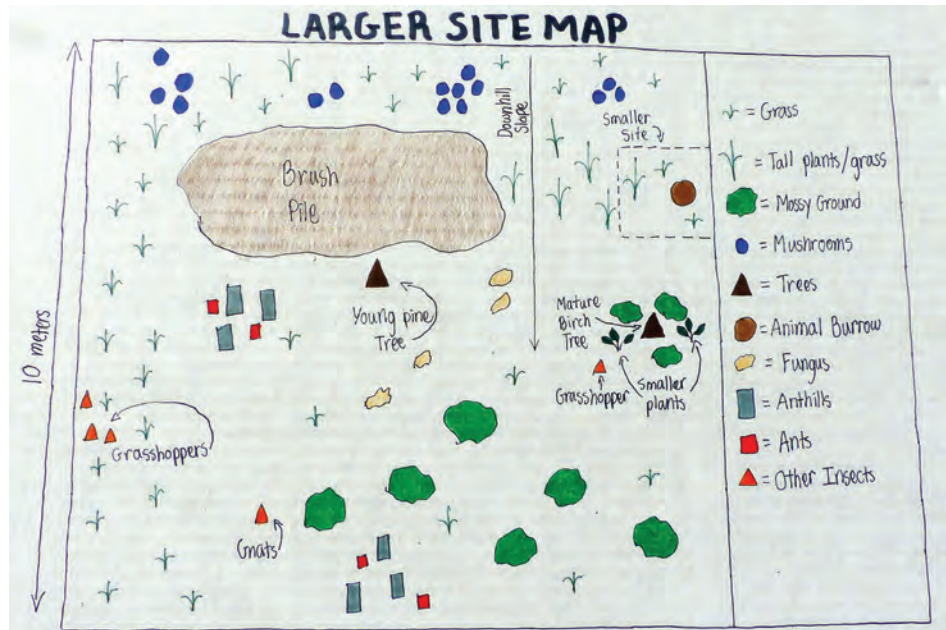
Lesson 4

(continued)

Lesson 4

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e. **Maintenance:** Is the area maintained? If so, do you know how often the area is watered, fertilized, mowed, or treated with pesticides?

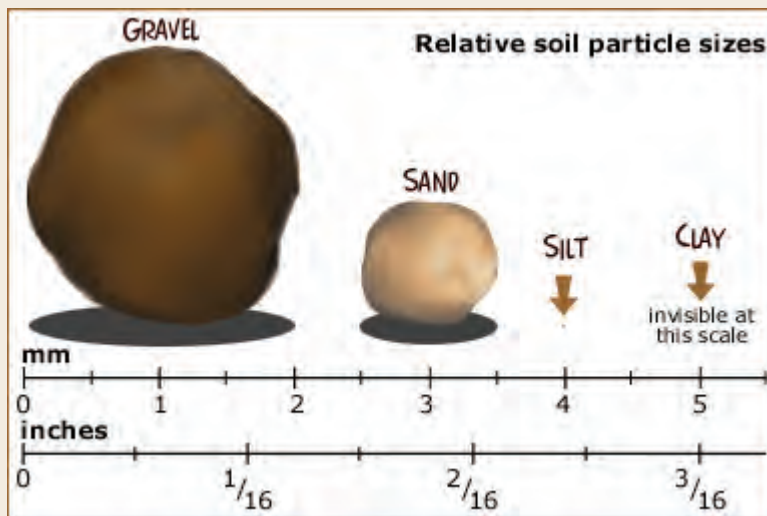


Credit: Jamie Masthay, Oak Meadow student, 2014

8. Now find a 2m x 2m area within your larger site that you would like to study in more detail. Stake out this area, and mark the boundaries of it with string. Draw the location of this smaller site on your larger site map.
9. Trying not to disturb the site, get right down on the ground and use your hand lens to inspect the area. Record the types of insects, plants, or other features that you see when looking close up.
10. Carefully collect a small sample of soil, and observe it with your hand lens. Describe the soil and any organisms you see living in it. Is the soil mostly sand, silt, clay, or is it loam? Is there organic matter in the soil?
11. *Extra credit (optional):* Prepare another, more detailed site map of your smaller site. Include a key specifically for this site.

Soil Types

Don't know the difference between sand, silt, and clay? It has to do with particle size. Sand is the most coarse, and feels gritty. Clay is extremely fine, doesn't drain well, and is harder to dig into. Silt is between these extremes. Many soils are a mixture of these, which is called *loam*. Loam is the best type of soil for plant growth. You may see organic matter (bits of decomposing plant or animal matter) in your soil. This is called *humus*. This image shows you the difference between the particle sizes of soil.



Credit: DiscoveryEducation.com

Lesson 4

(continued)

12. Take photos of your site, including close-ups of insects or plants that you can use to help you with identification later. These photos will also give you a comparison for when you revisit this field activity later in the course.
13. Look around at the area around your site. From a general visual survey, are there differences in the physical features or plant/animal life in the surrounding area compared to your site? Or is the entire area fairly uniform? Take brief notes on your observations; you will be answering this more fully in the analysis below.

Lesson 4 **Analysis**

(continued)

1. Using your field guides, identify as many of the plants or animals as you can.
2. Using your notes and your site map, prepare a written description of your 10m x 10m site. Write one paragraph.
3. Now describe the 2m x 2m site that you studied. Is this site characteristic of the rest of the large site?
4. Write a paragraph describing how your site compares to the area around it, as per the observations you noted in #13 above.

Extension

1. As the seasons change, the types of organisms that live in an area are likely to change as well. Predict how your area would change in a different season of the year. You will be exploring this later to see how accurate you are.
2. Describe at least two interactions between organisms on your site, or between an organism and its environment, based on your observations.
3. Based on your detailed observations and what you have learned about your site, think of a question that you could use for further investigation about your site. For example, you may want to consider the influence of humans (for instance, traffic or maintenance) on the site; study how two species interact (perhaps a predator/prey relationship); explore the effects of physical features, such as water or sunlight, on organisms; investigate larger animal traffic through the site; or explore a specific aspect of the site through the seasons. These are just a few of many possible examples! You may want to go “micro” and explore the fine details of a rotting log on the site.

Using the tools for scientific investigation that you learned in lesson 3, write a description of how you would investigate this topic. Please give specific details! Examples of details would be your times of observation, duration, frequency, etc. Remember, your investigation must be replicable. Since you are not required

to carry out this investigation, you can craft your investigation to use as long a time frame as you want.

Extra credit (optional): This project, and the subsequent visits to your site, is an introduction to phenology. If you really want to dig in and explore what this science is all about, you would need to make regular observations of a specific aspect of your site, such as a single plant and the area immediately around it, or your 2 meter x 2 meter smaller site. You will want to go out at least once a week and take notes on what you see, make sketches, and take photos from the same spot. This can be an exciting adventure, where you stick with it and continue the project throughout the year. If you choose this option, this will substitute for the revisiting of this project as explained in lessons 17 and 30. Please discuss this with your teacher for more information.

This extra credit option opens a great citizen science opportunity: Use the data you are collecting to contribute to a citizen science project! Visit *Nature's Notebook* (https://www.usanpn.org/natures_notebook) to see how you can contribute. This is a project that is creating a database of observations throughout the United States that will contribute to research, land management decisions, and policy decisions. You will see detailed instructions on how to take notes and submit your data. If you are not in the U.S., this is still a great website to learn more about phenology and tips for doing the extra credit option.

A final note

When you dismantle your string that marks your site, leave the stakes in, if possible, so when you come back to this later in the course (in lessons 17 and 30), you will know exactly where your site is. If this is not possible, take careful notes or measurements from landmarks, trees, etc. This, along with your photos, should help you find your site again.

Why Does This Matter?

For this lesson, this is a question that you should be able to answer yourself! Paying attention to the details required in a careful survey of an ecosystem gives you an introduction to the skills needed for science

Lesson 4

(continued)

Lesson 4

(continued)

research. Any time you raise your awareness of your surroundings, you become more “tuned in” to the world around you. Becoming a “noticer,” in the micro and the macro sense, can only help you as you go through life.

Why is phenology important? People who depend directly on the land to survive (as opposed to indirectly, which includes all of us), have seen changes in seasonal events in recent years because of climate change. In the tundra, people depend on the increased mobility that the frozen ground of winter provides to travel and hunt. What happens if winter comes late and leaves early? Different species of animals depend on the cycles of other animals for their survival. What if these cycles become out of sync because the timing of the seasons is different? The more baseline data we can gather about phenology, the more we can notice change when it happens, and predict the effects of future changes.

FOR ENROLLED STUDENTS

At the end of this lesson, please send your work from lessons 3 and 4 to your Oak Meadow teacher. Make sure your submission is organized and well-labeled.

Please submit all parts of this lesson to your teacher. You can either scan your handwritten notes, or type them into your Google course doc. Include your responses to all procedure, analysis, and extension questions, a photo or scan of your site map, and any photos that you have taken of your site. If you completed the extra credit assignment (a detailed site map of your 2m x 2m site), please include it with your submission as well.

Lesson



Economics and Environmental Policy

*We don't have to sacrifice a strong economy
for a healthy environment.*

Dennis Weaver, actor, humanitarian, environmentalist (1924–2006)

Another field that falls into the array of disciplines that make up environmental science is economics, which you will read about in this lesson. In fact, ecology and economics are very related—just look at the names! Go back to the Invent-a Word activity in lesson 2, and notice the word roots from both words that are listed there. *Ecology* is the study of our home, and *economics* is the system of rules or management of our home. In this course, the planet Earth is the home or household that we are talking about. More and more these days, it is becoming understood that we are all affected directly or indirectly by environmental events anywhere in the world. In this lesson, you will learn about what goes into policy making at the national and international level. If you think about the concept of perspective and the questions of the previous lessons, you begin to appreciate that international cooperation is a huge and remarkable undertaking. We have a long way to go, but global communication has come far, and the infrastructure is in place for many positive steps in our future.

A new term to become familiar with as we study how humans benefit from natural resources is *ecosystem services*. You will see it being used throughout the course. Keep this concept in mind as you learn about all the processes that occur in nature that benefit us.

ASSIGNMENT SUMMARY

- Read Chapter 2, Economics and Environmental Policy.
- Answer comprehension questions.
- Answer critical thinking questions.
- Choose one or more activities to complete:
 - Activity A: Ecosystem Services Value Survey
 - Activity B: Cost/Benefit Analysis
 - Activity C: U.S. Forest Service and National Park Service
 - Activity D: Protecting Land Assets

Lesson 5

(continued)

Learning Objectives

- Explain the relationship between economics and the environment.
- Relate the concept of values to environmental decision making.
- Read about the process of environmental policy in the U.S. and globally.

Ecosystem services:

the benefits that ecosystems provide for humans. These include services such as food, water, medicines, minerals, energy (things we take directly from the environment), as well as less measurable services such as crop pollination, nutrient cycling, purification of water and air, and aesthetic, spiritual, or recreational services.

Reading

Read Chapter 2, Economics and Environmental Policy (35–57), in your textbook.

Some of this chapter (lesson 2, pages 42–47) discusses the structure of the United States government and U.S. environmental policy. If you are not a citizen of the U.S., you may skip that section, but you should become familiar with the structure of your government and environmental policy in your country. If you are a U.S. citizen, please read the entire chapter. No matter where you live, you may still choose project options C or D about protected lands in your country or elsewhere.

Comprehension Questions

1. Describe four assumptions of economics and “business as usual” that have traditionally had negative outcomes for the environment.
2. Relate the concept of the frontier ethic described in “Think About It” to the terms *anthropocentrism*, *biocentrism*, and *ecocentrism* that you learned in chapter 1 (26). Which of these terms best describes the frontier ethic?
3. Cost/benefit analysis relies on assigning a monetary value to a resource or ecosystem service. Why is this often difficult?
4. Which international treaty resulted in reversing the destruction of the ozone layer?
5. What is the role of NGOs (non-governmental organizations) in shaping policy?
6. Explain, using examples, why international environmental laws are needed. You may include the Tijuana River as one of your examples.

Think About It

When early European settlers came to North America, they found nothing but vast, wide-open country, occupied by relatively few native people compared to the population density where they came from. The attitude that prevailed was one of “look at all this richness, here for the taking!” The settlers quickly moved through the land, consuming its natural resources as they went. When one area became depleted, they would move westward to conquer new frontiers. This attitude is known as the *frontier ethic*, which assumes that the Earth has an unlimited supply of resources, which are there for the taking. If the resources run out in one area, more can be found elsewhere, or human ingenuity will find alternatives. It is with this perspective that North America was developed.

The frontier ethic could be linked to other places in the world as well. When the British discovered how good sugar was in tea, Britain did everything it could to increase the sugar harvest in the Caribbean. That meant exploiting slave labor to grow the cane. Largely to feed the slaves, almost every last Atlantic cod was harvested from one of the richest fisheries in the world. It was said that there were so many cod that you could walk on their backs across the Atlantic and that we could never run out! Even humans were viewed as free for the taking, to be put to use as slaves for economic gain. European countries found minerals in Africa, and exploited that continent to obtain these resources, expanding their political dominion in the process. While the focus in these examples might not have been as much on individual growth and gratification as the westward expansion in North America was, the concept is the same. The environment was exploited for human gain, and the notion that the resources were unlimited was the prevailing attitude.

Discuss this issue with your family or fellow students. What type of ethic do you feel you have? Consider the concept of entitlement. Do the people where you live take what they have for granted? If you live in a developed country such as the United States, do you feel people are evolving to have more of an environmental or sustainable ethic as compared to the frontier ethic? Or do you feel people view natural resources as free for the taking and unlimited?

Lesson 5

(continued)

Lesson 5 **Critical Thinking Questions**

(continued)

1. Answer questions 2 and 3 in the Quick Lab on page 37. Discuss this with your family or fellow students to share ideas. What would you do?
2. When manufacturers are forced to pay a “green tax” based on the amount of environmental damage they cause, they may try to pass this cost to consumers by raising product prices. Given your understanding of the way the free market works, and considering personal responsibility, do you feel that raising prices is fair? Explain your answer.
3. Review comprehension question #3 in lesson 3 of this course, and your answer to it. Let’s expand on the scenario: Suppose you now know that the fish are dying because of the acidity in the water. With further investigation, it has been determined that the acidity is caused by acid rain, which is a result of sulfur dioxide being introduced into the atmosphere from coal-burning power plants hundreds of miles upwind. Which steps of the environmental policy process have already been completed? Describe the steps that need to be taken from here to solve the problem.

Activities

Choose one of the following activities to complete, or do more than one for extra credit.

- Activity A: Ecosystem Services Value Survey
- Activity B: Cost/Benefit Analysis
- Activity C: U.S. Forest Service and National Park Service
- Activity D: Protecting Land Assets

Activity A: Ecosystem Services Value Survey

Consider some ecosystem services in your area that are difficult to assign a monetary value. Perhaps you live near the ocean or the mountains, where the open space and aesthetic beauty are important to you. Perhaps there is a reservoir, used for recreation as well as a water supply. Maybe there is a park nearby where people go for quiet contemplation. Maybe you have a small garden or even a window box with flowers in it that brings you and your neighbors joy.

Come up with two questions you will use to create a survey of at least five people, to determine how much they value this ecosystem service, and which values are important to them. Use some of the values in figure 4 (40) to help you craft your questions. In a third question, ask them “How much is it worth to you to keep intact the place that provides this ecosystem service? What would you pay?”

This can be done through interview or email, but please use people in your own family or community. Note that you may have to explain what “ecosystem services” means as you conduct your interviews. Prepare a report summarizing your results. Include your questions in your report.

Activity B: Cost/Benefit Analysis

Imagine that you live in a town with a coal-fired power plant nearby. Many people are employed at the power plant and at a nearby coal mine. A neighboring county is building a wind farm to generate electricity. The wind farm will be operational in a few years. The town council has raised the question of whether the existing coal power plant should be closed, as the wind farm will produce as much or more electricity. Part of the cost/benefit analysis will be considering market values as well as non-market values in order to make a wise decision. Using the following list of values, discuss how each applies to this situation by writing one or two sentences for each value. Be sure both the wind farm and the coal power plant/mine are included in your discussion. Values that are not defined in the textbook are defined here:

- economic: the gain or loss of money or jobs
- aesthetic
- environmental: the protection of natural resources
- educational
- cultural
- scientific
- health: the maintenance of human health
- ethical/moral: what is right or wrong?

Lesson 5

(continued)

Lesson 5

(continued)

Activity C: U.S. Forest Service and National Park Service

In the United States, the early 1900s brought on some policies, inspired by early conservationists, that resulted in a system of protected lands that have served as a model for the rest of the world. These systems are run by the National Park Service and U.S. Forest Service. It can be confusing to understand the difference between a national forest and a national park. Sometimes we want to lump them both together. They are very different!

Learn about these two types of land assets that belong to all the people of the United States. Research the difference between these two agencies. What kinds of protections do each provide for their lands? What uses are allowed on each? What department of the federal government oversees each agency? Write one page. Include a picture or drawing of the emblem of each agency in your report.

Activity D: Protecting Land Assets

If you live in a country other than the United States, or if you would like to learn about another country of your choice, research what agencies or divisions of the government exist to protect lands, promote conservation, or regulate land use. Many countries throughout the world have a national park system. Are there national parks in your country? If you live there, have you been to any of them? What is the level of protection that they provide? What kinds of uses are allowed in the parks? Are they available for anyone to enjoy? Are there new parks being proposed? Educate yourself on this topic, and write one page.

Why Does This Matter?

You may have felt that some of the material in this chapter was rather intense, and it didn't stick well in your brain. That's okay; just be aware that the information is here. Now you know where to go if you want to brush up on how environmental policy is shaped. To make positive changes in the world, knowing the basics of how things work is essential. Understanding how tricky it is to assign monetary values to things like clean air or a beautiful view might help to build new

respect for those courageous and tenacious individuals who have helped shape environmental policy, past and present. In future lessons we will learn more about some of these amazing people, such as Rachel Carson, Theodore Roosevelt, David Brower, Wangari Maathai, and many more. It is through the action of individuals that come together for a common purpose that changes are made. It is at the local level, in small neighborhoods like yours, where changes are started.

FOR ENROLLED STUDENTS

You will be submitting this lesson's work to your Oak Meadow teacher after you complete lesson 6.

Lesson 5

(continued)
